Cornell University—Agricultural Experiment Station.

# TENTH ANNUAL REPORT

OF THE

# Agricultural Experiment Station.

## ITHACA, N. Y.

1897.



TRANSMITTED TO THE LEGISLATURE JANUARY, 14, 1898.

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STATE OF NEW YORK

No. 72.

# IN ASSEMBLY,

JANUARY 14, 1898.

# TENTH ANNUAL REPORT

OF THE

# Agricultural Experiment Station of Cornell University.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,
ALBANY, January 14, 1898.

*To the Honorable the Legislature of the State of New York:*

In accordance with the provisions of the statutes relating thereto, I have the honor to herewith transmit the 10th Annual Report of the Agricultural Experiment Station at Cornell University.

CHARLES A. WIETING,
*Commissioner of Agriculture.*


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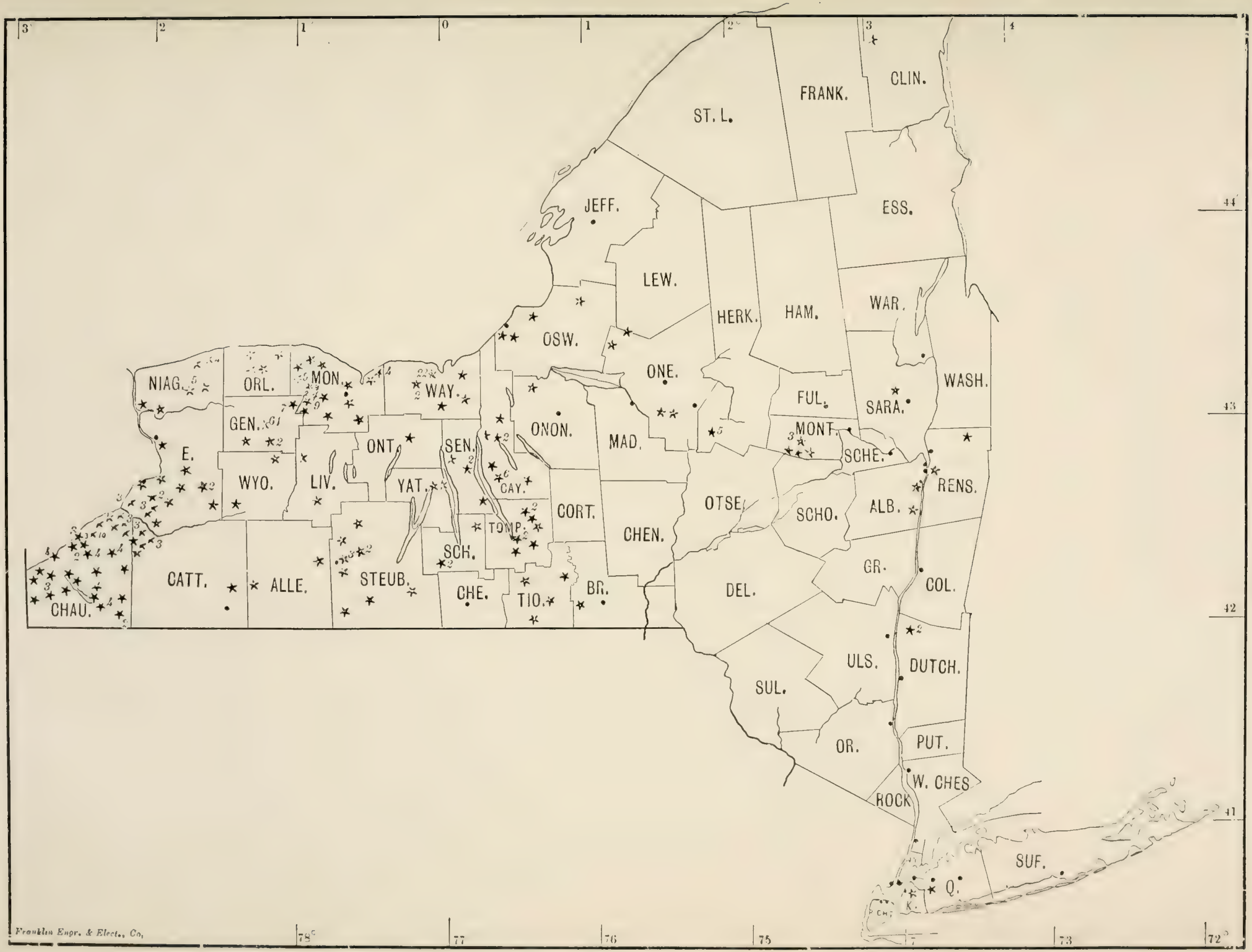

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| | |
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In pursuance of the provisions of Chapter 128 of the Laws of 1897, the following persons have been appointed investigators and instructors in the College of Agriculture of Cornell University to serve throughout the State according to the needs of the several localities for a portion or all of the year.

| | | |
|---|---|---|
| J. W. SPENCER, | M. V. SLINGERLAND, | MISS M. F. ROGERS, |
| G. T. POWELL, | B. M. DUGGAR, | A. L. KNISLEY, |
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# REPORT.

*His Excellency, the Commissioner of Agriculture of the State of New York, Albany, N. Y.*

SIR :—

I have the honor to transmit herewith the tenth annual report of the Agricultural Experiment Station of Cornell University, in accordance with the Act of Congress of March 2, 1887, establishing the Station.

While the investigations of the Station are all believed to be of great value, and the fourteen bulletins issued during the last six months are each and all worthy of note, I may be permitted to call special attention to the work in furtherance of scientific agricultural investigation carried on under Chapter 128 of the Laws of the State of New York for 1897. Through teachers' leaflets and similar means an attempt is being made to prepare the farmers of the State of New York for intelligent and helpful co-operation in the experiments carried on by the Station; and at the same time to carry on extensive experiments under the varying conditions of climate and soil which obtain in the different portions of the State. These experiments are at present in three lines, sugar beet culture, horticulture and the use of commercial fertilizers, and it will be readily seen from the maps accompanying this report, on how large a scale these experiments have been planned. I cannot but believe that the capabilities of the Station will by these means be enormously increased.

I have the honor to be your obedient servant,

J. G. SCHURMAN,
*President of Cornell University.*

# REPORT OF THE DIRECTOR.

*To the President of Cornell University.*

SIR :—

The letter of Mr. A. C. True, Director of Experiment Stations, Washington, D. C., hereunto attached, explains why this report is written at this time instead of at the end of the calendar year as has been the custom heretofore. It should be noticed that the financial part of this report covers the fiscal year ending June 30th, 1897 ; that part of it which relates to the publications and work undertaken covers but six months, January 1st to July 1st, 1897, and hence is not so extended as was last year's report which covered a full calendar year.

The State appropriated (Chapter 128 of the Laws of 1897) $25,000 for "giving instruction by means of schools, lectures and other University Extension methods, or otherwise, and in conducting investigations and experiments; in discovering the diseases of plants and remedies therefor; in ascertaining the best methods of fertilization of fields, gardens and plantations; and best modes of tillage and farm management and improvement of live stock; and in printing leaflets and disseminating agricultural knowledge by means of lectures or otherwise; and in preparing and printing for free distribution the results of such investigations and experiments, and for republishing such bulletins as may be useful in the furtherance of the work; and such other information as may be deemed desirable and profitable in promoting the agricultural interests of the State." This appropriation has made it possible to greatly enlarge the scope of our work and to employ additional help to carry on investigations and instruction in fields not heretofore covered. It has also made it possible to republish several valuable bulletins, which were out of print, for which there is a growing demand.

The work under Chapter 128, Laws of 1897, began in April and has been carried on vigorously up to the present time. Two sets of circulars were prepared and sent out, one in which were

given full directions for conducting culture experiments with sugar beets, selecting land, preparing the soil, planting, tillage, harvesting and preparing specimens for analysis, together with diagrams showing the size, number and arrangement of plats. The Department of Agriculture at Washington furnished the beet seed which was distributed to three hundred and sixteen experimenters. The experiments are being conducted in thirty-four of the sixty counties of the State. The other circular was prepared by the Chemical Department and it, in like manner, gave full directions for carrying out experiments with sugar beets and other crops on plats treated with commercial fertilizers of known weight and composition together with unfertilized check plats. The Station purchased and sent out two hundred and three sets, each set containing five small sacks of fertilizer. These investigations cover forty-sėven counties of the State and hence are, as well as those previously mentioned, being carried on under varied climatic and soil conditions.

The farmers of New York know but little about sugar beet culture, soil or fertilizers best adapted to the highest development of the beet. By these extended experiments it is hoped that much useful information will be disseminated and that the farmers will be led to carry on investigations on their own account in the future, while the Station will be able to discover the districts and the kind of tillage and fertilizers which give promise of highest results.

On the University farm twelve plats which are separated from one another and from the adjoining land by cemented brick walls two feet deep, have been planted to sugar beets, with and without fertilizers. Soil to the depth of two feet was removed, eight inches at a time, and placed in three piles. After the walls were built each pile of earth was thoroughly mixed and returned in the reverse order of its removal. It is hoped by this means to secure normal out door conditions while securing absolutely like conditions of soil-texture and composition.

The most difficult and original experiment undertaken is the introduction into the schools of what, for want of a more appropriate name, has been called "Nature Study." For a long

time many educators have seen that there is a great gap in the courses of study offered in the schools above the primary grade. By common consent it is agreed that no more courses can be added and it is not clear what studies, if any, can be omitted, but all agree that the youths of the land should become interested in the plants and animals and other natural objects by which they are surrounded and with which they will have to do in after life. It was found that by conducting the work, not as a study but as a rest exercise for a few minutes each day, great interest was aroused and that instead of adding to the pupil's work, it lightened it and created a desire to become better acquainted with Nature in garden, field and wood. To start this work, leaflets have been prepared by persons especially fitted for the work, these have been printed and distributed, usually to teachers, though in a few cases to the pupils.

Leaflets I., "How a Squash Plant gets out of the Seed;" II., "How a Candle Burns;" III., "Four Apple Twigs;" and V., "Some Tent Makers," have gone to a third edition; Leaflet IV., "A Children's Garden," for pupils and teachers, to a fifth edition; Leaflet VI., "What is Nature Study," to a second edition, and twenty thousand copies of Leaflet VII., "Hints on Making Collection of Insects," were issued June 1, 1897.*

Mr. John W. Spencer and Mr. John L. Stone, have conducted the Extension work and some of the experiments in the western half of the State. Mr. George T. Powell and Miss Mary Rogers have conducted like work in the eastern half of the State. Mr. George A. Smith and Mr. W. W. Hall have conducted the instruction in dairy husbandry throughout the State.

These three groups of experimenters and instructors have been assisted from time to time by the professors and instructors of the College and Station and by a few special helpers not connected with the University. Honorable Charles R. Skinner, Superintendent of Public Instruction, and Honorable Charles A. Wieting, Commissioner of Agriculture, have given us hearty and efficient support.

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* For a sketch of the origin and progress of the Agricultural Extension Work see Cornell Bulletin 137, May, 1897.

The majority of farmers are anxious to secure a better and more extended understanding of their profession. They are difficult to reach because they had no training in their special occupation while in school, and not because they are unwilling to learn. It is humiliating to look over the courses of study offered to farmers' children and see what scant and poor provision has been made for teaching anything which has a direct relation to tilling the soil or for giving any inspiration which might help them to discover the laws which govern the soil, the plant and the animal. This Extension work in Nature Study is as yet an experiment. Its aim is primarily to reach and help the teachers and through them the farmer with the hope and expectation that the pupils and their parents will be taught both useful and interesting facts and that they will come to see the need of investigating for themselves. Each farm and each crop has its own problems to be solved, the Experiment Stations can give valuable assistance, but climate, soil plants and conditions vary so widely that the farmer who desires to reach better results must experiment for himself. It is believed that the Extension work has materially assisted in securing the hearty co-operation of more than five hundred farmers in the experiments which are being carried on throughout the State.

The first object in issuing leaflets on Nature Study is to promote investigation, to arouse enthusiasm, to open the eyes of pupils and parents, in order that the future tillers of the soil may become better acquainted with Nature's laws and modes of action, thereby enabling them to direct Nature's laws so intelligently as to produce highest results.

Until the middle of this century no instruction nor real help had been offered to the tillers of the soil, so it is no wonder that the very foundations of scientific, applied and experimental agriculture are yet to be laid in the schools, or that the term "Nature Study" is selected in order to make agricultural instruction popular.

Fourteen bulletins embracing three hundred and thirty-three pages have been issued during the last six months on the following subjects:

No. 124, The Pistol-Case-Bearer in Western New York.

No. 125, A Disease of Currant Canes.

No. 126, The Currant-Stem Girdler and The Raspberry-Cane Maggot.

No. 127, A Second Account of Sweet Peas.

No. 128, A Talk About Dahlias.

No. 129, How to Conduct Field Experiments [with Fertilizers.

No. 130, Potato Culture.

No. 131, Notes upon Plums for Western New York.

No. 132, Notes upon Celery.

No. 133, The Army-Worm in New York.

No. 134, Strawberries under Glass.

No. 135, Forage Crops.

No. 136, Chrysanthemums of 1896.

No. 137, Agricultural Extension Work: Sketch of its Origin and Progress.

Circular No. 5, Concerning Co-operative Tillage Experiments.

Circular No. 6, Directions for the Application of the Fertilizers and Records to be made.

Brief reports of the progress of the work in charge of the various divisions of the Station and the Treasurer's report are hereunto appended, together with a detailed and classified report of receipts and expenditures for the fiscal year ending June 30, 1897.

Assistant Professor of Dairy Husbandry H. H. Wing has been given a leave of absence for nine months, and is now in Europe, making an extended study of the dairy industries of England, Holland, Sweden and Denmark. Therefore no report of progress in dairy husbandry is submitted. It may be said that extended investigations have been and are being conducted along dairy lines, the results of which will be published in the early part of next year.

Some extended investigations have recently been instituted by the Veterinary Division of the Station for the purpose of securing a fuller knowledge of the causes of contagious abortion in milch

cows in hopes that with a clearer understanding of causes a remedy may be discovered for this disease which has been so prevalent during the last quarter of a century and which has caused more loss in the dairy than all other diseases combined.

Reports which have reached us from many parts of the State during the last year indicate that the mortality among swine has been unusually large, due to causes which have not yet been discovered. Experiments have been begun with a view of determining the cause and remedy for this trouble.

The force of the Station has been doubled during the last two years, many investigations and experiments along lines which bear upon nearly every agricultural industry of the State are being vigorously prosecuted and the Station staff is working harmoniously and enthusiastically for a common purpose—the advancement of those industries which are embraced under the generic term "Agriculture."

I. P. ROBERTS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
WASHINGTON, D. C.

JUNE 29, 1897.

DEAR SIR:—

The experiment stations in 15 States now make the annual reports of their operations as well as their financial reports cover the fiscal year ending June 30. Now that this Department is required to make a report to Congress on the work and expenditures of the Stations for each fiscal year, it would be better as far as we are concerned if it was the uniform practice of the Stations to make their annual reports for the fiscal year. There is nothing in the Hatch act to forbid this. That act simply calls for an annual report without defining exactly the period to be covered.

If we could receive the report of the work and expenditures of all the Stations by September 1, it would enable us to make our report to Congress at the opening of the session in December. It would then receive proper consideration by the committees in connection with the appropriation bill. As it is now, the information available for these committees is a year old when the report is considered and may unfairly represent the condition of affairs at a number of the Stations at that time.

Very truly yours,

A. C. TRUE, Director.

# REPORT OF THE CHEMIST.

*To the Director of the Cornell University Agricultural Experiment Station.*

SIR :—

The following is a report of work done in the Chemical Laboratory between July 1, 1896, and June 30, 1897.

| Name. | Analyzed for | Number of Samples. |
|---|---|---|
| Soils | Water | 47 |
| Soils | Nitrogen, phosphoric acid and potash | 7 |
| Fodders | Fodder analysis | 34 |
| Fodders | Nitrogen, phosphoric acid and potash | 3 |
| Celery plants | Nitrogen, phosphoric acid and potash | 10 |
| Apple tree leaves | Nitrogen, phosphoric acid and potash | 3 |
| Urine of horse | Phosphoric acid | 8 |
| Grapes | Acid and sugar | 20 |
| Sugar beets | Sugar | 4 |
| Potatoes | Nitrogen and starch | 4 |
| Clover roots | Nitrogen | 4 |
| Clover tops | Nitrogen | 3 |
| Clover nodules | Nitrogen | 1 |
| Paris green | $As_2 O_3$ (arsenic trioxide) | 2 |
| Ashes | Phosphoric acid and potash | 1 |
| Commercial K salts | Potash | 2 |
| Water | Lime, magnesia and potash | 1 |
| Manure | Nitrogen, phosphoric acid and potash | 1 |
| Callerine | | 1 |
| | | 156 |

In addition the A. O. A. C. work was done on potash.

G. C. CALDWELL.

# REPORT OF THE BOTANIST.

July 1, 1897.

*Professor I. P. Roberts, Director.*

DEAR SIR :—

I have the honor to present the following report of the Botanical Division of the Experiment Station for the past six months.

There have been published two Bulletins during the year, as follows : A Disease of Currant Canes, Bulletin 125, February, 1897, by E. J. Durand, assistant botanist during the previous year. Two Destructive Celery Blights, by B. M. Duggar, assistant botanist. These articles were published in Bulletin 132, March, 1897.

Work is in progress upon the following subjects : A very thorough study has been made of several of the parasitic fungi known as anthracnoses which attack fruits and various vegetables. The matter is being prepared for a bulletin but considerable time is necessary to complete it because of the numerous illustrations. It is hoped, however, to present it sometime during the coming autumn.

A great deal of attention is being given to the preparation of illustrations in the way of fine photographs of the larger fungi known as mushrooms, with a view to publishing a series of bulletins on the edible, poisonous and indifferent species in the State, for the purpose of arousing an interest in the value for food of the edible species and to give simple directions for becoming acquainted with the more common species.

Studies are also in progress on the diseases of timber and forest trees, and already many valuable illustrations have been made for future bulletins of an educational character, as well as of scientific value.

In connection with this, investigations have been begun upon the development and embryology of certain of the forest trees, especially, at present, the pines and other conifers, with a view to determining rate of growth, distribution, fertility of seed, as well as the conditions which influence or modify the life of these trees.

Mr. B. M. Duggar, the assistant botanist, is engaged upon several lines of investigation. Practical and scientific studies are being made by him of certain celery diseases, and of the leaf spot of the pear. Other investigations are being started which will lead to important results it is hoped. Beside the work of investigation and of instruction which Mr. Duggar is carrying on, the correspondence is constantly increasing in reference to diseases of various kinds which attack fruits, vegetables, etc., so that a considerable part of his time is taken up with these matters.

The work of the year besides the results of the investigations has added materially to the equipment of the Division in the way of illustrations, negatives, etc., besides the additions to the apparatus by purchase.

Very respectfully yours,

GEO. F. ATKINSON,

Botanist.

# REPORT OF THE ENTOMOLOGIST.

*To the Director of the Cornell University Agricultural Experiment Station.*

SIR :—

As the carrying out of the Entomological work of the Station has been performed during the past six months almost entirely by the Assistant Entomologist, I have requested him to prepare a report on it, which I hereby transmit.

Very respectfully yours,

JOHN HENRY COMSTOCK,

Entomologist.

*To the Entomologist of the Cornell University Agricultural Experiment Station.*

SIR :—

During the period covered by this report (from January 1st, 1897, to July 1st, 1897), the work of the Entomological Division of the Station has been along the same lines as in previous years, but it has been of a somewhat different nature in some respects. Thus far, the year 1897 has been quite a remarkable one in New York State, so far as the prevalence of insect life is concerned. Many of our common insect pests which are more or less destructive every year have been conspicuously numerous and injurious, while some other insects which usually harass the fruit grower every year have attracted attention to themselves by their absence or non-occurrence in injurious numbers.

In the former class are to be mentioned plant-lice, which have been much more numerous and destructive on many different kinds of vegetation all over the State than for many years before; canker worms have again ravaged many acres of apple orchards in the western part of the State; in May and June, thousands of apple and wild cherry trees all over the State bore the unsightly tents

of the common apple-tree tent caterpillar (*Clisiocampa americana*), and many of the trees were entirely stripped of their foliage by the ravenous hordes of these caterpillars; at the present time (July 1st), the forest-tent caterpillar (*Clisiocampa disstria*) is ravaging acres of shade and forest trees in several parts of the State (it was mistaken for the gypsy moth in Delaware county); the pear psylla has again appeared in immense numbers in many pear orchards and the crop of fruit is seriously threatened. On the other hand, however, as we predicted in Bulletin 133, the army-worm seems not to have attracted attention anywhere in the State this year, although thousands of armies of the worms ruined thousands of acres of field crops last year; many of the larger plum growers in the State have been agreeably surprised this year to find that their old and dreaded enemy—the plum curculio—did not appear in numbers sufficient to make it necessary to go to the trouble and expense of fighting it; one of our largest quince growers also writes that the quince curculio (*Conotrachelus crataegi*) also appeared in surprisingly small numbers this summer; we had intended to begin a critical study of the life-history of white grubs this spring but were unable to find enough of the May beetles to start the experiment; for two or three years the crops of New York farmers have suffered from hordes of grasshoppers, but this year, doubtless owing to the work of their enemies and to climatic conditions, grasshoppers appear to be scarce in many localities.

Thus the year 1897 has thus far been one of peculiar interest, from an entomological standpoint, in New York. The facts given in the above paragraph have been brought out by our extensive correspondence and by personal observations while engaged in lecture work under the auspices of the Nixon Bill.

No new outbreak of any insect pest has thus far occurred which seemed to necessitate carrying on extensive experiments at the insectary in the study of its habits or methods of combating it. Our time has been fully occupied in continuing work that was begun last year or in previous years, also in preparing some of last year's results for publication, and in attending to the mass of correspondence arising from the sudden and unusually destructive outbreaks of the well-known insect pests mentioned above.

However, as the quince curculio was so destructive last year in some localities as to lead growers to seriously consider the advisability of cutting down their orchards, we have taken up the critical study of its habits this year and hope to be able to reach some practicable conclusions regarding methods of controlling such a serious pest.

The following bulletins have been published from this Division during the past six months:

No. 124, The Pistol-Case-Bearer.

No. 126, The Currant-Stem Girdler and the Raspberry-Cane Maggot.

No. 133, The Army-Worm in New York.

Our inability to get the results of our last year's study of the codlin moth ready for publication in the spring has enabled us to verify our observations this year; our conclusions will soon be put in shape for publication as a bulletin. The results of our last year's applications in our extensive peach borer experiment have just been ascertained, and they reveal some striking and valuable facts which will add much definite data to our knowledge of how to fight this serious peach pest. We expect to be able to collate and digest the details of our work with this insect which have accumulated during the past three years, and get the conclusions ready for publication during the coming year.

Our endeavor to give each correspondent the latest and best information at our command results in a rapid increase in the correspondence of this Division. About five hundred queries were answered during the past six months; fifty of these were prepared for publication in agricultural journals. The fact that we are thus often enabled to reach special and urgent cases quickly, renders the correspondence of this Division one of the most valuable and important features of its work. We have also published several technical articles in entomological journals.

Respectfully submitted,

M. V. SLINGERLAND,

Assistant Entomologist.

# REPORT OF THE AGRICULTURIST.

*To the Director of the Cornell University Agricultural Experiment Station.*

SIR :—

Since my last report to you two bulletins have been published by the Department, No. 130, Potato Culture, and No. 135, Forage Crops. These bulletins give the results of experiments extending over a period of two years. To verify the results published, the experiments are being repeated this year and the results will probably be published as a supplementary bulletin. An interesting line of work, and one which now promises well, is the intro-culture of grain crops. For three years the experiment has been conducted with wheat and this year it has been extended to oats. A question which is seriously puzzling the farmers of the State is how they can best control the wild carrot, the mustard and the cress, all of which have been abundant in the oat fields the past season. We believe that a practical solution of the question will be found in intro-culture. It remains now to have manufactured some implement so that the work can be performed cheaply and efficiently by horse-hoe tillage.

The study of leguminous plants and their comparative value as nitrogen gatherers, commenced last year, is being continued. An effort is being made to determine what portion of the nitrogen stored up by the clover plant is actually taken from the atmosphere and what from the soil. The investigation in connection with this work will necessarily have to be extended over a series of years.

Certain leguminous plants which in their native soil and climate produce root tubercles have been found not to produce them here. By a system of soil inoculation it is hoped that these nodules or tubercles may be induced to grow and that

we may thus add to the list of our valuable nitrogen-gathering leguminous plants.

In the spring of 1896, one thousand white ash seedlings were set in the University woodland. These seedlings were purchased and set at a total cost of only two cents each. From seventy-five to eighty per cent. of them are now living and making good growth. The result of this experiment so far would indicate that much of the hilly land unfit for cultivation could far more profitably be devoted to forestry.

Many causes have combined to awaken an interest in the manufacture of beet sugar. This department is conducting extensive experiments to determine whether the beets can be profitably grown in this State, what system of tillage is best, and what fertilizers are required to give the highest per cent. of sugar. Beet seed, with directions for planting the same and caring for the product, have been sent to over three hundred farmers who are co-operating in the experiment. The work with sugar beets at the home grounds this year is mainly in determining what fertilizers give best results both as to yield, sugar content and purity.

The work of the Division is largely confined to lines of investigation which are practical in their nature, and an attempt is being made not only to discover new truths but to emphasize and enforce old ones, and to show plainly that success in agriculture depends largely upon improved practices and methods of tillage.

Respectfully submitted,

L. A. CLINTON,

Assistant Agriculturist.

# REPORT OF THE HORTICULTURIST.

*To the Director of Cornell University, Agricultural Experiment Station.*

SIR:—

In the absence of Professor Bailey, I can make only a partial report of the progress of work in this Division from January 1st to July 1st, 1897.

Of the out-door work the successful contest with the San José scale is perhaps the most pressing for early publication. Two thorough and timely sprayings with kerosene and water, in a combination of one part to four, saved all the kinds of shrubs treated, and we have not seen a live insect since. This experience has brought out a number of points which will doubtless be welcome news in the midst of the general anxiety. Among the tree fruits, progress has been made in the permanent orchards which were devoted to carefully planned and far reaching fertilizer experiments. Some new varieties of Japanese plums are fruiting for the first time and the Station is fortunate in having the expert services of Mr. S. D. Willard, of Geneva, in judging the varieties of this popular new type of plums. A new vineyard has been set and important accessions made. The work in small fruit culture has consisted largely of local fertilizer experiments in six strawberry fields of Oswego county, the results of which are very gratifying and of great general interest. Two beds of strawberries have been set, one of new varieties, and one to continue the in-door work. In vegetable gardening we are in the midst of our second year of investigations with celeriac and Brussels sprouts. An acre of celery has also been planted on the onion meadows of Orange county in an attempt to introduce the culture of this crop within easy shipping distance of the large eastern markets. In floriculture the work is confined to studies of cannas, dahlias,

and to the vexed problems concerned in the forcing of Bermuda lilies for Easter, and to chrysanthemums.

The indoor work now looks toward a long series of cultural experiments in the forcing of fruits; collections of apricots, peaches and cherries are ready, and as soon as the proper facilities are at hand the growing of grapes from a commercial standpoint is to be undertaken. One of the smaller greenhouses has been remodelled for a strawberry forcing house to follow up the successful work of last winter, reviewed in Bulletin 134.

Very respectfully submitted,

C. E. HUNN, in charge.

# REPORT OF THE TREASURER.

*The Cornell University Agricultural Experiment Station, in account with the United States appropriation,* 1896–7.

| | Cr. | Dr. |
|---|---|---|
| To Receipts from Treasurer of the United States as per appropriation for fiscal year ending June 30, 1897, as per Act of Congress, approved March 2, 1897 | | $13,500 00 |
| By Salaries | $ 8,043 75 | |
| Labor | 1,988 57 | |
| Publications | 299 60 | |
| Postage and Stationery | 251 05 | |
| Freight and Express | 118 75 | |
| Heat, Light and Water | 63 84 | |
| Chemical Supplies | 147 49 | |
| Seeds, Plants and Sundry Supplies | 651 37 | |
| Fertilizers | | |
| Feeding Stuffs | 164 83 | |
| Library | 108 22 | |
| Tools, Implements and Machinery | 56 95 | |
| Furniture and Fixtures | 126 68 | |
| Scientific Apparatus | 772 82 | |
| Live Stock | 301 10 | |
| Traveling Expenses | 145 88 | |
| Contingent Expenses | 10 00 | |
| Building and Repairs | 249 10 | |
| | | 13,500 00 |

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Cornell University Agricultural Experiment Station for the fiscal year ending June 30th, 1897; that we have found the same well kept and classified as above, and that receipts for the year from the Treasurer of the United States are shown to have been $13,500.00, and the corresponding disbursements $13,500.00, for all of which proper vouchers are on file, and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purpose set forth in the Act of Congress approved March 2, 1887.

(Signed) H. B. LORD, GEO. R. WILLIAMS, } Auditors.

(Seal)

Attest: EMMONS L. WILLIAMS,
Custodian.

# APPENDIX I.

## BULLETINS PUBLISHED JANUARY–MAY, 1897.



## CIRCULARS.

**Bulletin 124.** **January, 1897.**

Cornell University Agricultural Experiment Station.

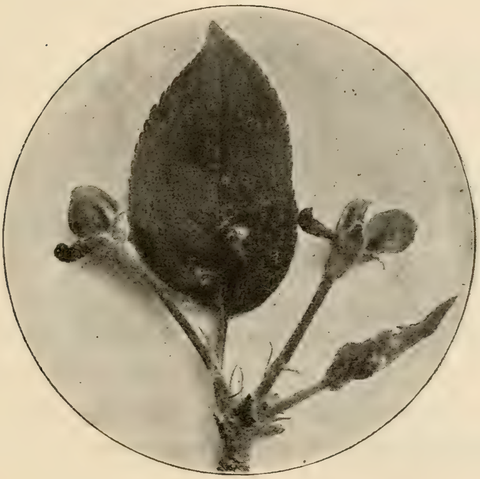
**ITHACA, N. Y.**

**ENTOMOLOGICAL DIVISION.**

# The Pistol-Case-Bearer

—IN—

## Western New York.



**By M. V. SLINGERLAND.**

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1897.

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Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

## BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.

CORNELL UNIVERSITY, ITHACA, N. Y., January 1, 1897.

THE HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

*Sir* :—The following paper considers another of the many insects which contribute their share towards making fruit-growing a scientific business. The observation of any insect and the study of truthful descriptions of it, are direct means of education; and the final mastery of it is a means of encouraging and fortifying the farmer in every adversity. This bulletin, therefore, has two distinct merits,—the imparting of immediate information concerning the pest, and the power of inspiring correct and hopeful habits of thought; it is therefore submitted for publication under Chapter 437 of the law designed to extend the experiment station method and work.

L. H. BAILEY.

# THE PISTOL-CASE-BEARER.

*Coleophora malivorella* Riley.

Order LEPIDOPTERA; superfamily TINEINA.

Among the most interesting insects that trouble the fruit grower are those known as "case-bearers;" thus named from the fact that in their destructive stage they are encased in curiously-shaped suits which they wear wherever they go. One of these insects, the cigar-case-bearer, has done much damage in western New York orchards since 1893; it was illustrated and discussed in Bulletin 93. During the past year another case-bearer appeared in large numbers in several apple orchards in western New York and proved even more destructive than the cigar-case-bearer. Frequently both kinds of these case-bearers and the bud-moth (Bulletin 107) worked together on the same branch.

In 1896, many New York farmers and fruit-growers became acquainted for the first time with several insects which seemed to have suddenly appeared in their field crops or orchards in destructive numbers. The army-worm, the green fruit worms (Bulletin 123), and the case-bearer under discussion, are illustrations of this fact. To many, these insects were new pests; and it is a remarkable fact that, although all of them have occurred in our state for many years and have at times been injurious, it has been nearly fifteen years since any of them appeared in sufficient numbers to do noticeable injury.

## HISTORY, DISTRIBUTION, AND FOOD-PLANTS OF THE INSECT.

This pistol-case-bearer is an American insect, and first attracted attention in 1877 in a large apple orchard of over 8000 trees in Erie County in Pennsylvania. The owner of this orchard reported that it seemed as if there was one on each bud on almost every tree in the orchard; the next year the insect was still more destructive, rendering large numbers of trees nearly leafless. Specimens of the insect were sent to Dr. Riley, and in 1879, he published (Ann. Rept. of Com. of Agr. for 1878, p. 253) a brief

illustrated account of the pest, describing and naming it as new to science. Scarcely anything new has been recorded about the insect since. What was doubtless the same case-bearer was recorded from Kentucky in 1878, and was found upon chestnut bark near Ithaca, N. Y., in 1880. In the spring of 1882, the insect did considerable damage in apple orchards at South Byron, N. Y. It did not again attract serious attention in New York state until 1896. In 1891, a few specimens were sent to Dr. Lintner from Lansing, Oswego Co., and Walworth, Wayne Co., and the same year we found some of the cases on a wild cherry tree near the insectary. The insect was reported as occurring in Nebraska and adjoining states in 1894, and we received a few specimens from Sodus, Wayne Co., N. Y., the same year. In 1895, it was found in Canada and in New Mexico. During the past year, the insect did much damage in large apple orchards at Geneva and at Walworth, N. Y. We also received it from Clarkson, Monroe Co., N. Y. It has been recorded from New Jersey as common on apple, plum and cherry.

Thus the insect has quite a wide range of food-plants, including the three orchard fruits just mentioned, and probably the chestnut. It is also widely distributed over the country, occurring from Canada southward through New York and Pennsylvania and westward through Nebraska into New Mexico. It has been injurious only in New York and Pennsylvania. Nothing can be predicted as to its future.

*How distributed.*—It is claimed that the pest was introduced into the far west on eastern nursery stock. This is doubtless by far the most fruitful source for the distribution of the insect.

## ITS APPEARANCE.

On account of its small size and peculiar habits, the insect itself in any stage, will rarely be noticed by the fruit-grower. But one of the curious suits, or cases as they are called, which the little caterpillar wears, is quite conspicuous, thus often revealing its presence to the casual observer.

*The caterpillar and its curious case.*—The insect is destructive only in its caterpillar stage, and yet the fruit-grower usually sees only the peculiar suit or case worn by the caterpillar. Several of

these curious cases with their inhabitants partly protruding from one end are shown much enlarged at *b*, *b*, *b*, plate 1; at *c*, plates 1 and 2, many of the cases are represented, natural size, attached to the branch. The cases are of a dark brown or black color, more or less covered with grayish pubescence from the leaves. Their form is aptly described by the word "pistol-shaped." They are of a tough leathery texture, and evidently made of silken threads interwoven with the pubescence from the leaves, and the whole stained dark in some manner, probably by the excrements of the caterpillar. How this curious case is made will be described further on in discussing the life history of the insect. When the insect is at work in April, May, or June, these curious pistol-shaped cases are quite conspicuous, and certainly very odd-looking objects, as they are seen projecting at various angles from a flower-bud (frontispiece), from the surface of a leaf, or from the side of a branch (*c*, plates 1 and 2). They are sure to arouse one's curiosity, especially when, after watching one for a few minutes, it is seen to move off to another part of the bud or leaf.

1.—*Work of the pistol-case-bearer on apple foliage. Natural size.*

A careful examination of one of these moving pistol-shaped objects will reveal its inhabitant, an orange-colored, black-headed caterpillar about one-fourth of an inch in length.* When dis-

*Technical description of larva.—Length, 6 mm. Color, deep chrome or light orange; the thoracic segments are darker, the first one blackish.

turbed the little creature retreats into its pistol-shaped case and can be induced to come forth only by either tearing open its case, or by continued urging from the rear.

*The adult insect.*—The moth is a very delicate and pretty little creature. It is represented nearly four times natural size at *a*, *a*, plate 1; the male moth, which is considerably smaller, is shown in the lower of the two figures, and the larger female in the upper figure. They are of a general dark drab color; on the basal third of the front wings white scales predominate in the females, but are sometimes almost entirely lacking in the males. The alternation of the rings of dark and white scales give the antennæ and legs a curious annulated appearance. The basal joint of each antenna in both sexes bears a conspicuous tuft of scales, those of the female being considerably larger.* All of these characteris-

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Head, black with a yellow median suture; antennæ, yellow. Thoraci segments each with a blackish, granulate, chitinous spot on the lateral ridge; the mesothoracic segment has besides two similar, narrow, triangular, black, transverse spots, separated by a narrow yellow mesal line near its caudal border, and there is a similar subdorsal black spot on each side near the cephalic margin; the thoracic shield is large, black, and nearly divided by a narrow yellow median stripe. The anal shield is also black. The true legs are black, with the distal segment and the extremities of the other segments yellowish. The four pairs of pro-legs are of the same color as the body, except the anal ones which are slightly darker and have a large black spot near the base of each. The whole surface of the body is granulated, more strongly so on the thoracic and anal segments. A few hairs arise from the head, thorax and anal segment.

This description, taken from full-grown living specimens of the caterpillars differs considerably from Dr. Riley's description in his report for 1878. None of the caterpillars that Dr. Riley had, seem to have been preserved, so that we cannot explain these striking differences.

*In his description of the moth (Ann. Rept. Com. of Agr. for 1878, p. 254), Dr. Riley states that the males have no tuft on the basal antennal joint; he describes the tufts of the females. How this mistake occurred is not known. Mr. L. O. Howard, U. S. Entomologist, writes me as follows: "There are ten specimens of *Coleophora malivorella* in the National Museum collection. Five of these are males and five are females. The tuft on the basal joint of the antennæ occurs in *both* sexes, but is a little longer in the females than in the male. One of these males has lost the tuft entirely and in another is partly gone. It was also completely lost in one of the females.

All of these ten specimens are from the original 1878 rearings. Dr. Riley probably examined the single male which had lost the tuft."


PLATE I.—*The pistol-case-bearer* (*Coleophora malivorella* Riley). a a, *the moth* (*the upper figure represents the female and the lower one, the male insect*), *enlarged about four times;* b, b, b, *small cases, with the caterpillars projecting from them, much enlarged;* c, *an apple branch bearing several of the case-bearers in position for moulting;* d, *the eggs, very much enlarged.*

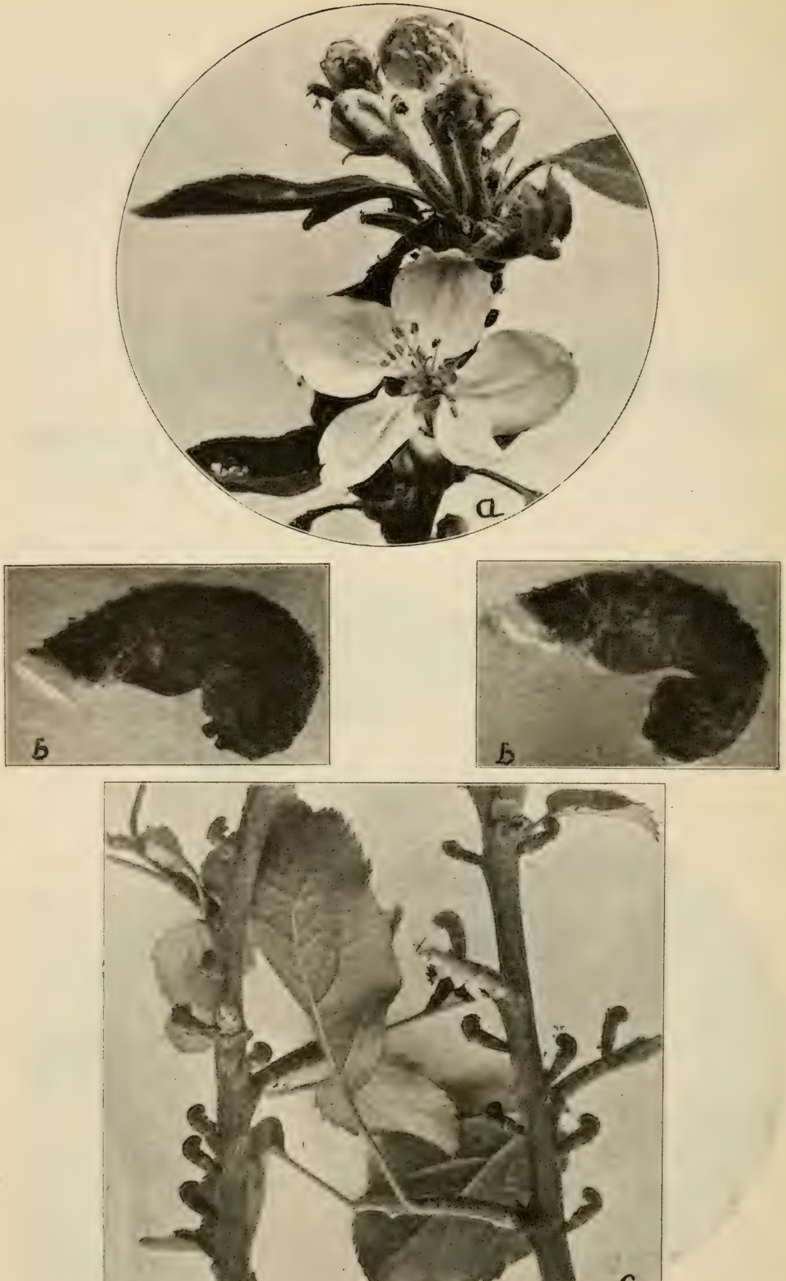


PLATE II.—*The pistol case-bearer* (*Coleophora malivorella* Riley). a, *destructive work of the insect on apple blossoms, natural size;* b, b, *cases showing recent white additions at the ends, much enlarged;* c, *full-grown case-bearers attached to the branches for pupation, natural size.*

tics are shown in the figures at *a*, *a*, plate 1. The general color of the males is slightly darker, especially the head.

During the day the moths rest on the leaves and branches with their heavily fringed wings folded closely over the abdomen and their long, slender antennae placed close together and projecting straight forward from the head. They may be seen in this position on the trees in June.

### ITS NAME.

This case-bearer belongs to the large group of minute moths known as Tineids. Nearly all the Tineids are easily distinguished from the other moths by their narrow wings which are bordered with very wide fringes (see figure *a*, plate 1). The name *Coleophora malivorella*, by which the insect is recognized among scientists the world over, was given to it by Dr. Riley in his report as U. S. Entomologist for 1878 (published in 1879).*

The popular name of "apple coleophora" given to the insect by Dr. Riley was soon superceded by Dr. Lintner's name, "the apple-tree case-bearer." While it is true that it seems to prefer the apple as a food-plant, there are several other case-bearers which feed upon the apple tree, and one of these—the cigar-case-bearer (Bulletin 93)—is even more common and destructive than the one under discussion. We therefore propose the much more definite and descriptive popular name of "the pistol-case-bearer" for the insect. The striking resemblance of the case, which the caterpillar carries about with it, to a pistol makes this popular name especially suggestive to the fruit-grower.

### THE STORY OF ITS LIFE AND HABITS.

This interesting little pistol-case-bearer has been under almost

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* In Bull. 1, Vol. IV, p. 93 of the U. S. Geol. Survey, published February 5, 1878, Mr. V. T. Chambers described *Coleophora multipulvella*. In 1882, Lord Walsingham placed this species in the synonomy of *C. malivorella*, stating that Chamber's description applied to Dr. Riley's specimens, but that the former's type of *C. multipulvella* was not examined. Should Chamber's type specimen prove to be Dr. Riley's *C. malivorella* the last name must fall, on the ground of priority of publication, and the pistol-case-bearer be called *Coleophora multipulvella*. If Chamber's type is still in existence this point could be easily settled by some one familiar with the Tineids.

daily observation here at the insectary from the time it awoke from its winter's sleep in April, 1896, until it passed through its wonderful transformations into the pretty little moth, from whose beautiful and oddly-shaped eggs the little caterpillars hatched in the fall and soon made their preparations for their long winter's rest. While its life history is similar to that of the cigar-case-bearer (Bulletin 93) its habits are quite different and present several interesting phases of insect life.

*How it passes the winter.*—In our cages the little creatures began to go into winter quarters as early as August 26th; they were then minute, less than half-grown, orange-yellow caterpillars, encased in very small pistol-shaped suits, which were firmly attached to the bark, usually on the smaller branches. These hibernating cases are about one-half as large as those shown natural size at *c*, plate 1, and they are shaped like the much enlarged case shown at *b* in the extreme upper right-hand corner of plate 1. Where the insect is quite numerous, it may be easily found in its winter quarters.

About seven months of the pistol-case-bearer's life is spent in idleness in its snug little case on the twigs of the trees.

*Its spring appearance and habits.*—The little caterpillars awake from their long winter's fast very early in the spring, as soon as the buds begin to swell. In 1896, the little cases were loosened from the twigs soon after April 1st, and the march of the hungry caterpillars for the buds began; by April 15th, they were at work in full force on the buds. By eating or boring small holes, scarcely larger than a pin in the swelling fruit and leaf buds, the little creatures did much damage very early in the season. On April 24th, we examined the large orchards of Messrs. Yeomans, at Walworth, N. Y., and found the pistol-case-bearers so thick in one apple orchard that it seemed as though there was one case to every two or three buds on the trees; the buds were just beginning to open.

As the caterpillars continue feeding on the opening buds, they soon find that their winter suits or cases are too small for their growing bodies; and they proceed to build on extensions at both ends and along the lower edge.

*Its pistol-shaped suit.*—Unlike the cigar-case-bearer (Bulletin 93)

the pistol-case-bearer does not construct an entirely new and larger suit to accommodate its increasing size. It simply pieces on additions to its suit from time to time. In the enlarged cases represented at *b*, *b*, plate 2, the white portion at the head end is a very recent addition to the case; the right-hand figure also shows a slight addition around the anal orifice. We have specimens of cases which show fresh, white additions all along the lower edge of the case as well as at both ends. These additions seem to be made mostly of silk in which is mixed considerable of the pubescence and *debris* of the leaves, and the whole is glued together to form a tough leathery substance. Although white when first made, the additions soon become stained a very dark brown, perhaps from the excremental or other juices of the caterpillar. After about May 1st, the caterpillars seem to confine nearly all of their extensions to the head end of their suits, thus considerably lengthening the barrel of the "pistol." When complete then, their cases are simply their first winter suit that has been made larger around and longer by additions or patches put on to one side and both ends. Externally the cases or suits present a rough, fuzzy, somewhat untidy appearance, but cut one of them open and take a peep inside. The whole suit is found to be lined with a thin, smooth, whitish, delicate layer of silk which gives the interior a neat, cozy appearance.

The curved end which forms the handle of the "pistol" consists of two flattened oyster-shell-like projections of the suit, which are not joined together along their lower edges, and thus form a slit-like opening that is the back-door to the case. The elasticity of the material and the peculiar curve of this portion of the suit tend always to keep this opening closed. It would require considerable force for an *outside* enemy to open this orifice, though from the inside the slightest pressure enables the caterpillar to protrude its anal segment whenever its excrement is to be voided. This arrangement enables the little caterpillar to keep his snug home neat and clean inside. This back-door also serves another important purpose in the life of the insect, as we shall see later.

*Moulting of the caterpillar.*—On April 26th, we were surprised to find that most of the caterpillars at work in our cages had securely fastened their cases to the bark of the twigs as shown at

*c*, plate 1. On May 1st, Messrs. Yeomans, Walworth, N. Y., wrote me that the insects had also done the same thing in their orchard. It seemed hardly possible that they had finished their destructive work thus early, and were preparing to undergo their further transformations. Cases were detached and examined every day, and no explanation was found for the curious preceedure until the fourth or fifth day. Then the cases began to move, and at each spot where a case was fastened there remained attached to the bark the anchor, a minute cup or button of silk, and on each of these we found the cast skin of the head of the caterpillar. This meant that the cases had been fastened to the twigs so that the caterpillar could shed off, undisturbed, its old skin that had become too small, and could then come forth clad in a new and elastic skin that had been growing under the old one. All caterpillars moult or shed their skin several times; it is the way they grow. Doubtless the pistol-case-bearer moults at least three or four times during its life as a caterpillar, and perhaps in the way just described. Apparently the moult which occupied the last four days of April, 1896, was the last one; its occurrence in the heighth of the feeding season rendered it quite conspicuous.

*Its feeding habits on the flowers and leaves.*—Beginning on the swelling buds, as described on a previous page, the case-bearers continue their destructive work on the opening leaves and flowers. They now feed quite differently from the cigar-case-bearers, which mined out the tissue between the two skins of the leaves. The pistol-case-bearers either devour the whole leaf or all of it but the lower skin and veinlets, thus skeletonizing it, as shown, natural size, in figure 1. The caterpillar never leaves its case, but projects its body out far enough to obtain a good foothold and then begins to eat, holding its case at a considerable angle from the leaf. The cases are thus not attached to the leaf, but move with every motion of the caterpillar as it feeds. While they feed freely on the leaves, they seem to show a decided preference for the opening flowers; this habit makes the insect especially destructive. In the upper part of figure *a*, plate 2, is shown a cluster of flowers which has suffered severely from the attacks of this little foe. It works mostly on the petals of the flowers, but often eats into the stem and soon kills it. Thousands of prospective fruits

were thus "nipped in the bud" in the orchards where the insect worked. After the opening flowers are destroyed or the petals have fallen, the caterpillars turn their attention to the tender foliage. We placed about a hundred of the little cases on a small tree in the insectary that contained no flower-buds. Nearly every leaf on the tree was soon riddled like those shown in figure 1. The insect thus has more destructive feeding habits than the cigar-case-bearer, but as it feeds openly, and does not mine out its food from the interior of the leaf, it would seem to be easier to reach with a poison spray than the latter.

The pistol-case-bearers continued to feed on the leaves until about May 15th, when most of them migrated to the branches where they securely fastened their cases to the bark. Projecting upward from the branches at an angle of about 45 degrees, these full-grown pistol-cases present a peculiar appearance ; this is well shown at *c*, plate 2. So securely are the cases fastened that they often remain on the branches for a year or more, but they are of no further use to the insect after about a month.

*Pupation*.—After making all secure in the manner just described, the little caterpillar proceeds to prepare for its wonderful transformation to the adult insect—the moth. It first turns around in the case, so that the head is towards the anal opening in the handle of the "pistol." If a case be torn from the bark and carefully cut open about two weeks after it was fastened down, its inhabitant will not be a caterpillar, but a curious light brown, apparently lifeless object—the pupa. This change to a pupa took place about June 7th, in our cages.

*The emergence of the moth and egg-laying*.—The insect passes from ten to twenty days of its life as a pupa in its old pistol-shaped suit fastened to the branches, as shown at *c*, plate 2. From the curved slit (formerly used as a back-door by the caterpillar) in the under side of the handle of the "pistol," there emerges, from June 17th to the 30th, the adult insect—the pretty little moth described on a previous page and figured at *a*, *a*, plate 1. Thus, the pistol-shaped cases serve as snug warm suits for the caterpillars during their life, and then furnish cozy homes in which the insect undergoes its transformations. Other records give the time of appearance of the moth from the first to the

fifteenth of July, or about two weeks later than our rearings in 1896. This may be accounted for by the fact that the spring of 1896 was a remarkably early one and one also well adapted for the development of insect life; the case-bearers got to work earlier than usual, for the apple buds started nearly two weeks in advance of most seasons.

The moths remain at rest on the leaves during the day, doubtless feeding but little, if any, and doing no damage. Although dozens of moths emerged in our cages during the latter half of June, we found no eggs until July 13th. But the next day, hundreds of them had been laid all over the sides of the cage and on all parts of some apple branches therein. Further observations in the field showed that they were glued fast at their base usually to either the upper or lower surfaces of the leaves. Apparently no one had ever seen the eggs of this case-bearer before, for nothing has been recorded about them.

The eggs are of a cinnamon-rufous color, and are very pretty objects when seen under a microscope. Although they are only .42 mm. (.016 of an inch) in diameter at their base and about .27 mm. (.01 of an inch) in height, they can be seen with the naked eye when one knows where to look and what for. With our micro-camera we succeeded in getting some much enlarged pictures of these curiously shaped eggs; the photographs are reproduced at *d*, plate 1. As the figures show, the eggs remind one of inverted tea-cups with strongly ridged sides. Many fine transverse ridges connect the larger ones, and the deep cavity at the upper end of the egg is quite irregular in shape. They are very different from those of the closely allied cigar-case-bearer. Although a few recently-hatched caterpillars were seen July 14th, most of the eggs did not hatch until a week later; the egg stage thus last about a week in July.

*Habits of the recently-hatched caterpillar.*—Unlike the cigar-case-bearer, the newly-born caterpillar of the pistol-case-bearer is not a miner, and also begins the construction of its suit soon after it begins to eat. It first eats into the underside of the leaf, making a hole about the size of a pin's head nearly through the leaf. During this first meal, the little caterpillar apparently weaves together with silken threads some of its excrement and a few of

the leaf-hairs, and thus forms around its body a tiny cylindrical case or suit. We have several of these cases that were made July 22, 1896. The caterpillars continue to eat holes in the leaves during July and August, making additions to their suits from time to time and gradually giving them the pistol-shape.

*Preparations for winter.*—On August 26th, several of the little case-bearers in our cages migrated from the leaves and fastened their cases to the bark of the apple branches. These cases were of the same shape as those shown at *c*, plate 1, but about one-half as large. Doubtless most of the caterpillars stop feeding and fasten their cases to the branches before September 15th. In these snug, warm, and secure quarters the insect passes the winter.

*Briefly summarized*, the life-history of the pistol-case-bearer is as follows: The insect spends about seven months (from September 1st to April 1st) of its life in hibernation as a minute, half-grown caterpillar in a small pistol-shaped case attached to a twig. In the spring the caterpillars attack the swelling buds, the expanding leaves, and especially the flowers (frontispiece, and figure *a*, plate 2). About May 1st the cases are fastened to the twigs (Fig. *c*, plate 1) where they remain for four days, during which time the caterpillars shed their skin or moult. They do not make any complete new suit as they grow, but are content with making additions (Figs. *b*, *b*, plate 2) to the ends and side of the old suit. They are not miners, but feed openly, eating irregular holes in the leaves, often skeletonizing them. They are most destructive on the flowers where they eat the petals and stems. In the latter part of May, they cease feeding, securely fasten the cases to the branches (Fig. *c*, plate 2) and in about two weeks, change to pupae within. The moth (Figs. *a*, *a*, plate 1) emerges in two or three weeks, and soon glues its minute, pretty, cinnamon-colored, inverted cup-like eggs (Fig. *d*, plate 1) to the surfaces of the leaves. The egg-stage lasts about a week, the little caterpillar emerging about July 22d. They begin eating little holes in the leaves, and during their first meal construct of silk and excrement a small case or suit for themselves. They continue feeding on the leaves, adding to their suits from time to time, until about September 1st, when they begin to migrate to

the twigs and there fasten their little pistol-shaped cases to the bark. The winter is passed in these snug, warm, secure quarters.

### NATURAL ENEMIES.

We have not met with any natural enemies of this case-bearer. However, in 1879, Dr. Riley recorded that "the only enemy of this insect, so far as known, is a minute Chalcid fly, which has increased to such an extent since the ravages of the case-bearer became apparent on Mr. Fairweather's place (Erie Co., Penn.) that it bids fair to render additional remedies unnecessary. The specimens sent in 1877 were not parasitized. Those sent in 1878 were about half of them affected, and of twenty-four specimens received in March, 1879, seventeen had been destroyed by this little fly."* It is to be hoped that this little enemy will soon find a congenial home in the western New York orchards where the pistol-case-bearer is so numerous.

### HOW TO COMBAT THE INSECT.

It is practicable to fight this case-bearer in its caterpillar stage only; and it is then so well protected in its case as to render its destruction dependent upon very thorough work.

It is very doubtful if any spray will reach the insect in its snug winter quarters. Extensive experiments have shown that the cigar-case-bearer, which winters in a similar manner, cannot be checked by a spray at this time. The only time when the pistol-case-bearer can be effectively reached is when the caterpillars are actively feeding in the spring. As they feed openly upon the buds, leaves, and flowers, and do not *mine* like the cigar-case-bearers, a poison spray thoroughly applied on their feeding grounds should kill many of them.

We have had no opportunity of carrying on any experiments against the insect, but Messrs. Yeomans, Walworth, N. Y., have given us the results of their efforts to check its ravages. The fact that many cigar-case-bearers and bud moths were doing much damage on the same trees where the pistol-case-bearer was at

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*Mr. L. O. Howard, U. S. Entomologist, writes me that this Chalcid is a species of *Pteromalus*, probably undescribed. He also states that the pistol-case-bearer has a secondary parasite; it is Riley's *Cirrospilus flavicinctus*, described in Dr. Lintner's First Report, p. 159, as a primary parasite of *Bucculatrix*.

work, rendered it difficult to make any definite estimates of the results of spraying for the latter insect. Where the pistol-case-bearer was most numerous, they sprayed some of the trees twice before the blossoms were fully open, with Bordeaux mixture and London purple. On May 1st, Mr. L. T. Yeomans wrote us: "We may be mistaken, but it seems to us that we have not so many cases on our trees, where we have sprayed the second time." Kerosene emulsion was also tried when the insects were feeding in the latter part of April. A barrel of the emulsion was sprayed upon five trees, but Mr. L. T. Yeomans reported on May 11th, that he was unable to preceive any difference in the effect on the worms between trees thus sprayed and those unsprayed.

These experiments and our study of the habits of this pistol-case-bearer lead us to believe that it can be kept in check by *thorough* work with a Paris green spray, using one pound to 105 or 200 gallons of water, or Bordeaux mixture. The experience of Messrs. Yeomans indicates that it will require two applications of the poison before the blossoms open to effectually check the pest where it is very numerous. It would be well to combine the poison with the fungicide, Bordeaux mixture, in one of these sprayings, perhaps the second one, as this is the time when the apple scab fungus should receive its first check. This period between the swelling of the buds and the opening of the flower is also just the time when the bud moth and the cigar-case-bearer (which often work with the pistol-case-bearer) should be treated to a poisonous dose. As all three of these insects do their most destructive work before the blossoms open, an especial effort should be made to spray more thoroughly than usual. Do not wait until after the blossoms have fallen before striking a blow at these pests; although many of the pistol-case-bearers could doubtless be poisoned by a thorough application of the Paris green made just after the petals fall, which is also the best time to spray for the codlin moth or apple worm.

*Never spray a fruit tree when it is in blossom. Remember that your success in fighting the pistol-case-bearer, and any of the other insects just mentioned, will depend almost entirely on how thoroughly the spraying is done.*

MARK VERNON SLINGERLAND.

**Bulletin 125.** **February, 1897.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

**BOTANICAL DIVISION.**

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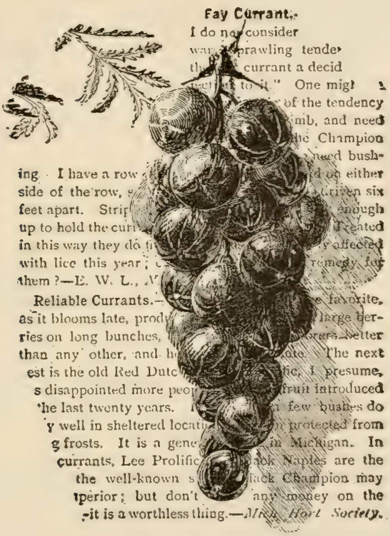
# A Disease of Currant Canes.






**By E. J. DURAND.**

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ITHACA, N. Y.

1897.

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# BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.

CORNELL UNIVERSITY, Ithaca, N. Y., Feb. 1, 1897.

THE HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

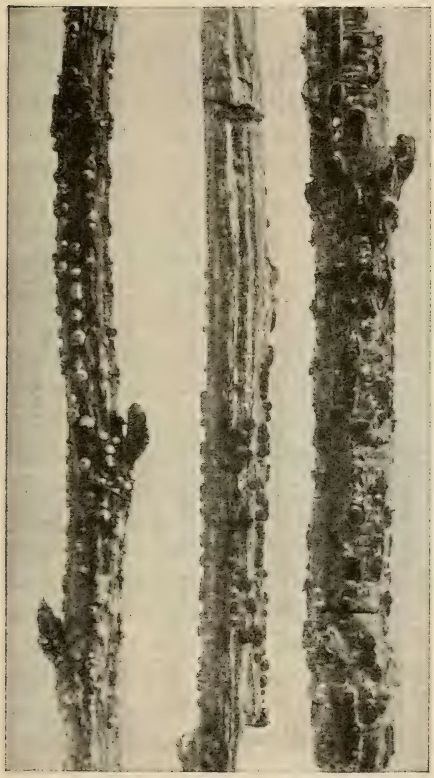
*Sir:* The following account of a currant disease, of which almost nothing has heretofore been known, is submitted as a bulletin under provision of Chapter 437 of the laws of 1896. This cane-blight is probably more widespread and serious than anyone has suspected, and it would not surprise us if it should be found that much of the trouble with currants which is laid to hard winters and poor soil is really the result of the work of this fungus.

L. H. BAILEY.

2. *Diseased currant plant, showing dead canes and shriveled fruit.*

# A DISEASE OF CURRANT CANES.

## I. GENERAL CHARACTER OF THE DISEASE.



a. b. c.

3. *Diseased currant canes, natural size* (a, *Tubercles of Tubercularia;* b, *clusters of perithecia of Nectria;* c, *clusters of perithecia of Pleonectria*).

During the last few years there has existed, in various portions of New York state, a disease of currant bushes, which has been more or less destructive to the currant industry. The trouble was first called to the attention of the Experiment Station staff in June, 1895, when a diseased bush was received at the Botanical Department from Portland, Chautauqua county. Outside of this locality its effects have since been observed by the present writer at Canandaigua, Ontario county, and in the gardens of the Horticultural Department of Cornell University, in Tompkins county. It has also been noticed by Professor G. F. Atkinson in St. Lawrence county. Outside of New York state it has been reported from New Jersey by Dr. B. D. Halsted.

Inasmuch as the disease seemed to be a destructive one its study was thought to be of interest and importance. It was de-

termined, therefore, that the writer should visit the locality of the trouble in Chautauqua county to observe its effects upon the currant bushes, and to obtain material for study. Accordingly, on the 26th of June, 1895, the fruit-farm of Mr. I. A. Wilcox was visited, and notes taken upon the disease as it appears in the field.

### *Effects of the Disease.*

The currant plot was found to be about one acre in extent. It originally consisted of several acres, but the death of the plants reduced it to the present size. About two-thirds of the bushes in the area at the time of the visit were either dead or manifestly diseased. The plants which had died the previous year were replaced in the spring of 1895 by new plants, which at this time were apparently unaffected.

The first effects of acute disease in the plant are seen in the wilting of the foliage, and the premature coloration of the fruits. The leaves turn yellow, dry up and fall away. The fruit clusters on affected plants are usually much smaller and more thinly fruited than on healthy ones, while the berries are colored prematurely, shrivel and fall away with the leaves, so that the canes are barren (Fig. 2.) The latter then die rapidly and soon dry up. Frequently the central canes of the bush die in the manner described, while the outer ones still retain their leaves. In nearly all such instances, however, the leaves of the living parts show indications of disease. Sometimes the plants die before the leaves unfold, so that the unopened flower and leaf buds may be seen upon the dead branches. In the worst cases, where all the canes are dead, the roots also die. Occasional instances were noted where fresh sprouts had been sent up around the base of the diseased canes.

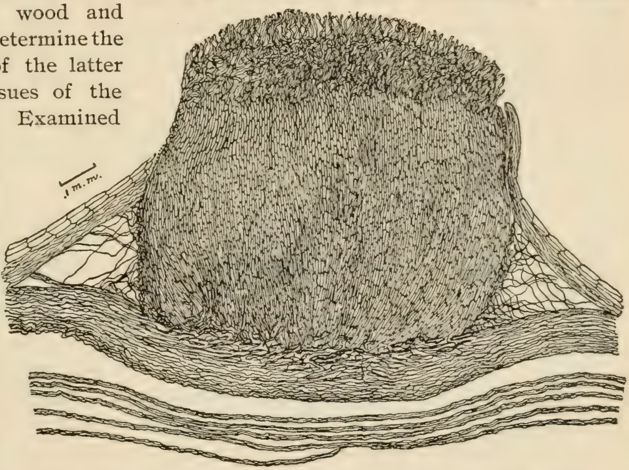
Cuttings made from apparently healthy bushes in this plot were unusually slow in growth, many of them not starting at all. Those which did start were very backward and amounted to but little. Two-year-old plants were also backward and slow in growth. The action of the cuttings suggests that the mycelium of the disease may be perennial in the tissues of the host plant, or, at least, that the vitality of the branch may be impaired before the effects of the disease begin to be noticeable.

## II. THE BOTANICAL CHARACTER OF THE DISEASE.

### *The Fungus.*

On a great majority of the dead canes the pink tubercles of a fungus of the genus *Tubercularia* were present (Fig. 3, *a*). They occurred most abundantly near the base of the stalk, but occasionally were found high up on the stem. Very few bushes were seen which had no tubercles on any of the canes. Sometimes they were present on much diseased stems not completely dead. In no case were they present on healthy plants. The tubercles were sufficiently abundant and so distributed on the diseased and dead stems as to render it probable that the fungus produced the disease and caused the death of the plants. A careful search was made for perithecial forms, but they were found on only a single plant. These with several specimens of the *Tubercularia* were collected for study.

An examination showed the tubercles to be the fruiting bodies of a well known species, *Tubercularia vulgaris*, Tode. Careful sections were made through the wood and tubercles to determine the connection of the latter with the tissues of the host (Fig. 4). Examined under the microscope, one of these sections shows that the vegetative part of the fungus consists of a delicate thread-like mycelium spreading abundantly through the tissues of the currant stem. The depredations are confined to the younger tissues of the host, within which it forms a wide weft between the cells. It thrives well in the inner bark or cambium layer, thus cutting off the nutriment and causing the death of the plant. The cells affected by the mycelium are much disintegrated and turn brown.



4. *Longitudinal section of a tubercle of Tubercu ria.*

The hidden mass of mycelium coursing through the tissues is the part that is destructive to the currant plant, since this is the only portion of the fungus that absorbs nutriment. The pink tubercles are the fruiting organs of the fungus. In their formation numerous threads of the mycelium turn outward from the bark as a bundle of closely compacted parallel filaments. As

growth progresses outward the mass brakes through the epidermis of the host, and appears as a pink cushion on the surface of the stem. A longitudinal section through one of these when examined under the microscope presents the appearance represented in the figure. The long, spreading mycelial threads may be seen coursing through the layers of the bark forcing the cells apart. In the tubercle itself the threads are broader and much septate by cross partitions, so that the mass thus formed resembles a tissue composed of narrow elongated cells. Toward the top of the tubercle the filaments are more compacted and thread-like. At the surface they become separated from one another and sparingly branched, each bearing small spores or conidia at its apex, and on very short branches or stigmata along its sides (Fig. 5). These conidia are exceedingly small measuring only 6–8$\mu$ long by 3$\mu$ wide. They are narrowly elliptical in outline and colorless. Immense numbers of conidia are borne on each tubercle, and, being so small and easily detatched, are scattered widely by the wind, thus forming a very efficient means of spreading the disease. Each conidium is capable of germinating under favorable conditions of temperature and moisture. The slender tube thus produced enters the tissues of the host, where it elongates and branches producing an abundant mycelium.


5. *Hyphæ of Tubercularia bearing conidia.*

The perithecia found on one of the canes were not fully mature, but were sufficiently so to admit of the determination of the species as *Pleonectria berolinensis*, Saccardo. This was afterward found to be a separate fungus in no way connected with the *Tubercularia*. All of the canes collected on the trip were planted in the leaves and humus in one of the nearby ravines, in the hope that more of the perithecial forms would be produced.

## *The History of the Fungus.*

The *Tubercularia vulgaris* is a very common fungus which has long been known as a saprophyte growing on dead and decaying branches. Nearly all of the deciduous woody plants are numbered among its hosts, the genus *Ribes*, to which the currant belongs, being a favorite in this respect. It has passed under many names according as the forms on the various hosts were regarded as belonging to the same or distinct species. In 1865, Tulasne (Selecta Carp. Fungorum, III), united all these forms under the old name *Tubercularia vulgaris*, Tode, and gave numerous drawings and facts to prove its connection as an imperfect stage with the very common ascomycetous species, *Nectria cinnabarina*, (Tode) Fr. That this connection exists is evident, so that the fact has since stood unquestioned. In regard to the

special relation existing between these fungi and the currant, Dr. M. C. Cooke wrote for the Gardiner's Chronicle of Feb. 28, 1871, a short paper entitled "A Currant Twig and Something on it." Here were described in a popular way the pink cushions of *Tubercularia*, the mycelium, and the connection of this form with the globular, compound heads of the perfect stage *Nectria cinnabarina*. The plant described in this paper was found on a dead currant branch pulled out of a brush pile.

*Its Occurrence as a Parasite.*

Most of the writers treating of *Nectria cinnabarina* have spoken of it in a general way, as a saprophyte growing on dead or decaying woody plants. It has long been known, however, that both the *Tubercularia* and *Nectria* may thrive upon living plants in a truly parasitic manner. In Germany this condition seems to be not uncommon. As early as 1880, Dr. H. Mayr[1] studied the fungus as it occurred on living horsechestnut, maple (*Acer platanoides*), and linden, besides noting it upon elm, *Spiræa* and *Prunus*. In the case of the maple the spores germinated upon the cut end of a branch of a young tree, sometime during the year 1880. The mycelium spread to the main stem killing a portion of it. Here the first tubercles appeared, probably in the fall of the same year. During 1881, the new wood was seized upon and killed, so that in the autumn of the same year the leaves withered and died. At this time perithecia appeared on the tubercles of the previous fall. The same writer also studied the development of the fungus, describing and figuring the germination of the spores, and the conidial and perithecial forms. In 1893 and 1894, Wehmer studied some peculiar developments of *Nectria cinnabarina* on linden,[2] *Carpinus*,[3] and *Juglans regia*.[3] J. Behrens,[4] also, found the fungus parasitic on *Abies balsamea*. In the summer of 1896, Mr. B. M. Duggar, of the staff of this Station found the same fungus growing in a truly parasitic manner on a pear tree at Fayetteville, Onondaga County, N. Y.

The first mention of *Nectria* as a parasite of currants seems to be that of Dr. Halsted, who speaks of it as follows :[5] "In the currant regions of the state, particularly around Hilton and Irvington, there has been complaint of a blight affecting the canes of the currant. . . . . . . An affected plant may often be detected by the wilted foliage and premature coloration of the fruit. In some instances only a single cane in the bush may be attacked, while in the worst specimens the whole shrub is dead, except the fresh sprouts which may have arisen from the base of the plant. In early

[1] Ueber den Parasitismus von *Nectria cinnabarina*. Unters. a. d. forst-botanischen Institut zu München **3** : 1–16, 1883.

[2] Zum Parasitismus von *Nectria cinnabarina*. Zeitschrift f. Pflanzenkrankheiten. **1894** : 74.

[3] Einige weitere Beiträge zum Parasitismus von *Nect. cinnabarina*. Id. **1895** : 268–276 Pl, V.

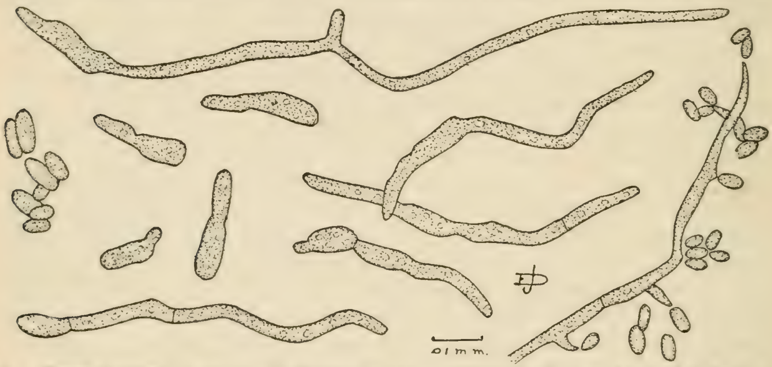
[4] Ein bemerk. Vorkommen v. *Nectria cinnabarina*, und verbreit weiss. d. Pilze. Id **1895** : 193–198.

[5] New Jersey Ag. Exp. Station, Report for **1894**, : 327.

July the blighted twigs often have their bark ruptured, and through the rifts there is to be seen a somewhat brick-colored fungus growth. Upon examination with the compound microscope, this red development is found to be the spore-bearing organs of a highly organized fungus belonging to the genus *Nectria.* This genus is not an unusual one among the fungi that are harmful to higher plants. . . The one upon the currant, when it seems to be deeply seated and does much damage, is nearly related to the *Nectria cinnabaria*, Tode, which is common on various trees." The effects of the disease in New Jersey are thus seen to be nearly identical with those observed in Chautauqua County.

*Cultivation of the Tubercularia.*

On November 16th, 1896, another package of diseased currants was received from Mr. Wilcox. The canes were badly affected, being thickly studded, especially about the lower ends, with the pink cushions of *Tubercularia.*




6. *Germinating conidia of Tubercularia. Portion of mycelium producing secondary conidia.*

The stems were covered and allowed to stand for a day in a moist place, so that the cushions were well moistened and swollen out. In order to avoid contamination as much as possible the spore-bearing tops of several of these cushions, after being shaved off with a sterilized scalpel, were crushed in boiled water on a flamed glass slip. Vast numbers of conidia were present. Dilution cultures of these were then made in acidified potato-agar in the usual manner. This was done in order that the germination of the conidia, and the development of the mycelium in artificial culture media might be studied. After twenty hours the spores had begun to germinate freely. The various stages of germination are illustrated in Figure 6. In this process the spore first swells to more than twice its original size through the absorption of moisture. A small protrusion then appears at one or each end of the conidium, which grows in length as a germ-tube. These tubes are quite large in proportion to the size of the spore, so that as growth pro-

gresses the original spore is soon lost sight of. In most cases the germ-tubes are soon cut off by septa. The protoplasm is at first nearly homogeneous, but soon becomes vacuolate in the older portions of the tube. After having elongated considerably the thread becomes sparingly septate by the formation of cross partitions. In old cultures the older parts of the mycelium are much sepate and filled with vacuoles. The threads soon begin to branch, until finally a spreading mass of densely interwoven mycelium is produced.

In threads thirty-six hours old, numerous small, short protrusions appear along the sides of the threads near the ends. These at first resemble incipient branches, but are usually of considerably less caliber than the main threads. They are as often curved as straight. When the bud is a little longer than the diameter of the main thread, a constriction appears near its base, so that the apical portion soon separates as a secondary conidium (Fig. 6). The base then grows out, so that other conidia are thrown off from the same point in a similar manner, until small clusters are present along the sides and apex of the main hypha. In old cultures these secondary conidia are present in immense numbers. As represented in the figures, the primary and secondary conidia are borne in precisely the same way along the sides and at the apices of hyphal threads. Being alike also, in size and shape, they differ only in that the primary conidia are produced on more or less erect hyphae, arising from the summits of the compact pink cushions formed by the coalesence of hyphal threads. The secondary conidia, on the other hand, are borne on separate hyphae, arising directly from the spores, and thus not forming a compact stroma. Morphologically, however, the two fruit forms are exactly alike.

Many cultures of the conidia of *Tubercularia* have been made, in all of which the mode of germination and production of secondary conidia were as described in the preceding paragraphs. Many of the cultures made from fresh material were more or less contaminated by the presence of bacteria or other fungi. In one set, however, plates two and three were pure, being thickly beset with numerous colonies of the *Tubercularia* alone. From plate three of this series transfers were made with a flamed needle to tubes of sterilized bean stems and potato-agar. At this time the colonies were about four days old, and secondary conidia were present in great numbers. Pieces of agar containing colonies were also transferred to sterilized currant stems in an Ehrlenmeyer flask.

On the potato-agar growth was rapid and profuse. The surface of the medium was soon covered with a felty growth, many of the hyaline threads extending far down into the mass. On the bean stems, also, the growth was rapid. The surface of the liquid was covered with a hyaline, felty growth, from which many of the threads projected downward as in the agar. The growth on the stems was sparse consisting of a thin weft of hyphae covering the substratum, and forming white flocculent tufts at the ends of the stems. After eleven days growth numerous small, hemispherical heaps or cushions began to appear on the bean stems at various points. These, at first, were

simply little tufts of threads about the size of a pin-head, but later they increased to several times that size. They were then pure white, somewhat compacted, and cottony in appearance. When examined under the microscope, these cushions were found to consist of erect parallel hyphae, much like fertile threads, but no conidia have yet been detected upon them.

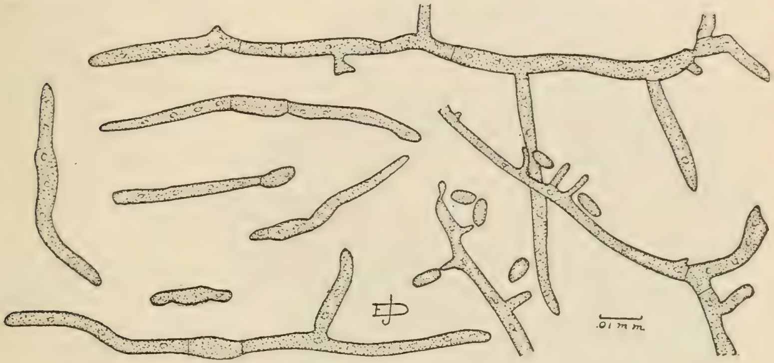
On the currant stems in the Ehrlenmyer flask growth was at first slow. In a few days, however, a long sparse growth of mycelium could be seen spreading thinly over the surface of the stems. In a short time the mycelium became somewhat flocculent in spots, especially at the cut places where branches had been removed from the stems. After fourteen days growth, the white cushions began to be formed, especially at the cut surfaces mentioned. In appearance these were exactly like the ones described on the bean stems. When old they became yellowish, and closely compacted into a stroma, which was slightly pinkish within. Several instances have been noted in which a swelling or protrusion appeared at the summit or side of one of the white cushions, and which seemed at first to present every indication of a forming perithecium. It was soon found, however, that the protrusion was simply a true, pink stroma of *Tubercularia*, resembling in nearly every respect those found in nature. Conidia were present in great numbers at the summit of the mass. In the flask, also, on the felty mass covering the surface of the currant leaves and liquid at the bottom, small pink tubercles have arisen, which in many respects resemble those found on the currant stems in nature.

It may be mentioned at this point, that in none of the artificial cultures has there appeared any indication of the fruit-bodies described by Mayr[6] as macroconidia. These were said to be long, fusoid, several-septate bodies, borne on tufts of white mycelium, at points where the stromata of *Tubercularia* later appeared. The macroconidia after germination produced secondary macroconidia of a similar form, by budding-off from the mycelium. It was thought at first, that the white cushions mentioned in the last paragraph might represent these macroconidial stromata, but a careful search has failed to reveal any fruiting-bodies of such a form. The fact that no such bodies appeared in the carefully made pure cultures, together with their very marked similarity to the conidia of a very common saprophytic fungus of the genus *Fusarium* has raised the suspicion that perhaps the macroconidia may have belonged to another fungus not connected with *Tubercularia*.

In order to determine the function of the secondary conidia thrown off from the mycelium growing in agar, dilution cultures were made, that they might be obtained in pure cultures. This was done by transferring a portion of a *Tubercularia* colony, containing numerous secondary conidia, to three agar tubes successively and pouring into plates in the ordinary manner. Plate number one was then examined under the microscope, and the position of the conidia marked on the glass. After twenty-two hours these

[6]Untersuch. a. d. forst-botan. Inst. zu München. 3 : 1–16, Pl. I, figs. 18–21.

marked spores were found to have germinated in a manner similar to that described for the primary conidia taken from the pink tubercles. The spores first swelled to several times their former size, when germ-tubes were pushed out from the sides and ends (Fig. 7). The protoplasm was granular and filled with vacuoles. Septa appeared early, cutting off the tubes at their points of origin. After forty-eight hours growth, the mycelium was found to be much branched, quite dense, and not widely spreading. The main hyphae had put out short branches quite simultaneously along their sides, so that the lateral branches were of nearly equal length. After fifty-six hours these branches were throwing off secondary conidia precisely as tbe mycelium from the primary conidia had done (Figs. 6 and 7). It will be seen, therefore, that the primary and secondary conidia behave almost exactly



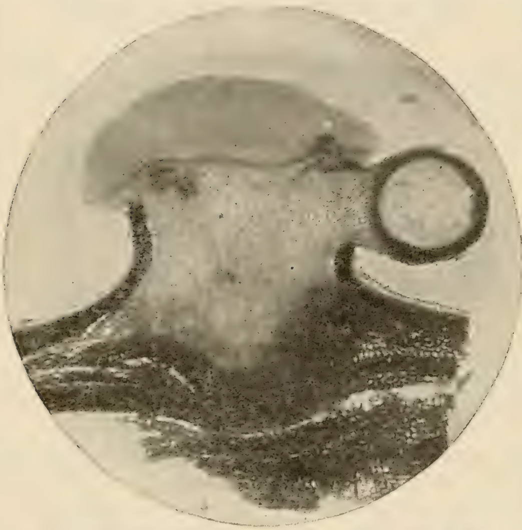

7. *Germinating secondary conidia of Tubercularia.*

alike in their germination, and in their production of fruiting bodies. This is no more than might be expected when we remember that the two forms are morphologically similar.

The behavior of these colonies varied much with the food supply. In plate number one, after the nutriment had become nearly exhausted on account of the large number of colonies present, the mycelial threads became very profusely and compactly branched, forming close colonies. The protoplasm became full of very large vacuoles. In plates number two and three, where the nutriment was more abundant, the threads were much longer, more slender, and less branched, thus forming a more spreading colony. The protoplasm was nearly homogeneous with few vacuoles.

On March 14, 1896, colonies produced from secondary conidia were innoculated on sterilized currant stems, neutral bean stems and acid bean stems. Here again the growth was similar to that described for the primary conidia. The mycelium grew slowly, but after three days, formed a thin weft over the stems. After four or five days the small white cushions began to form and increase in size, in nearly every respect resembling those previously described.

The various cultures and innoculations detailed in the preceding paragraphs were made in the hope that it would be possible, finally, to trace in artificial cultures the exact relation and connection existing between the *Tubercularia*, and the perithecial forms of *Nectria* and *Pleonectria*. It may be said, however, that at the time of the present writing, after a lapse in some cases of many months, nothing but the stromata of *Tubercularia* has appeared in the cultures. In explanation one might cite Mayr's observations on the maple (see p. 27). In this case the perithecia did not appear until a full year after the stromata had been formed. It is known, too, that many forms require a much longer time than this to attain to their complete development under artificial conditions. The methods of culture may not have been favorable to the production of the perfect form. It is known that many species require a period of rest before such forms will be developed. That a connection exists between *Tubercularia vulgaris* and *Nectria cinnabarina* has been abundantly demonstrated, so that the fact is no longer open to question (Mayr, l. c.)



9. *Longitudinal section of a stroma and single perthecium of Nectria.*

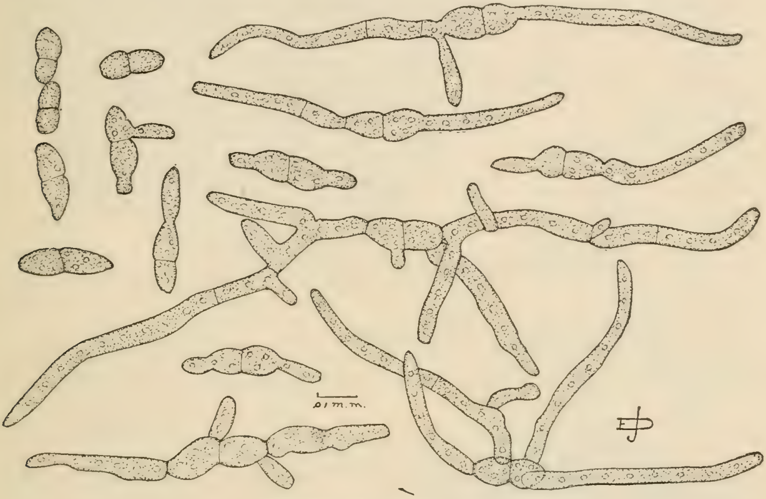
*Nectria cinnabarina.*

All of the perithecia developed during the fall of 1895, on the currant bushes planted in Fall Creek Ravine, were those of *Pleonectria*, which is not connected with *Tubercularia* as is shown in a succeeding paragraph.

The canes were examined at intervals during the fall and winter of 1895–96, but it was not until February that a branch was noted, on which clusters were present, which differed decidedly in appearance from those previously observed on this material (Fig. 3, *b*.) The perithecia were a light brick-red in color, were small, spherical, and densely crowded, and covered with little granules, giving them a rough appearance. There was no depression at the apex as in *Pleonectria*. The clusters were seated on prominent stromata, evidently those of *Tubercularia* (Fig. 3, *b* and 9.) The tubercles and perithecial clusters were intermingled freely. Many tubercles

were present, from the bases and sides of which the perithecia were projecting. All gradations could be seen, from the simple tubercles covered with conidia, through those bearing one or several perithecia, to those entirely covered by clusters. Conidia were present on all of these stromata.

A microscopical examination showed, as was suspected, that the fungus in question was none other than *Nectria cinnabarina* (Tode) Fr. If a perithecium be split longitudinally an appearance represented in Figure 9 is produced. It consists of an outer shell composed of coalesced threads. Springing from the bottom of this are numerous club-shaped sacks or *asci* which converge toward the apex of the perithecium. Each ascus contains eight elliptical spores which are divided into two cells by a cross-wall near the middle. They measure $12–15 \times 5–7\ \mu$.




10. *Germinating spores of Nectria.*

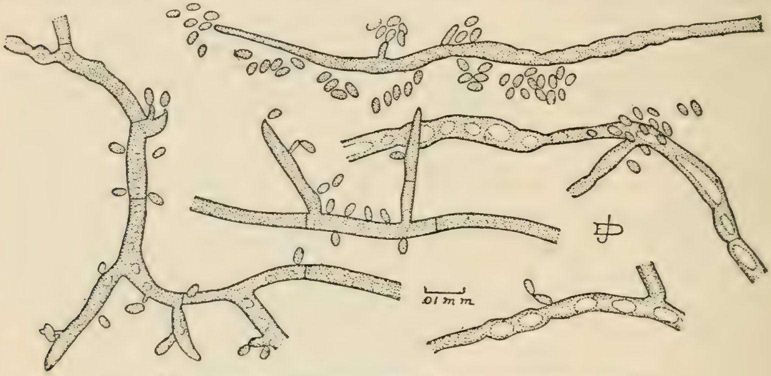
Cultures of the mature spores were made in acidified potato agar. The upper part of a cluster of perithecia was cut off with a flamed knife, the contents crushed out in boiled water, and dilutions made in the ordinary way. The plates were kept at the room temperature, 70 to 80 °F. The spores swelled and germinated after twenty-two hours. In nearly every instance both cells of the spore germinated, each sending out one or two germ-tubes (Fig. 10). The tube more often originates at the end of the spore than at the side. There is often a more or less prominent constriction of the germ-tube at the point where it leaves the spore.

At this time no septa were present, the protoplasm of the tube being continuous with that of the spore, and faintly vacuolate. After twenty-eight hours branching had begun and a few septa formed. From this time growth advanced rapidly until the threads had branched into a spreading myce-

lium. After three days, the protoplasm became full of vacuoles placed at regular intervals. At this time conidia began to be thrown off from short lateral branches in a manner similar to that previously described. They were 4—5 $\mu$ long, or about the size of those of *Tubercularia* (Fig. 11).

When the cultures were four days old small portions of the agar containing colonies were transferred to sterilized currant and bean stems. The mycelium spread from the point of innoculation until a sparse cottony growth appeared over the stems, especially at the cut ends. Development was more vigorous on the currant than on the bean stems. After nine days growth minute white cushions began to be formed on the surface of the stems. These increased in size, and resembled in every way those previously described for *Tubercularia*. No perithecia have yet been produced in artificial cultures.

Cultures were also made of the conidia produced on stromata from which perithecia were borne. The germination, mycelial growth, and white cush-




11. *Mycelium of Nectria producing secondary conidia.*

ions produced resembled exactly the like phenomena in the case of *Tubercularia*.

*Pleonectria berolinensis.*

Reference has already been made on a previous page to the perithecia of *Pleonectria berolinensis*, Sacc. found on one of the currant canes brought from Chautauqua county. This species has long been known as an inhabitant of dead currant stems both in Europe and America. In North America it is said to occur on dead stems of *Ribes*, in Canada and the Northern United States, west to Montana.

No reference to this fungus as a parasite has been found. At the time the specimen was collected it was thought that perhaps the species might be another perfect form connected with the *Tubercularia*. The evidence, however, is against this view.

The currant bushes which had been placed in the ravine, as described on page 26, were left undisturbed during the summer and fall of 1895. About September first, perithecia began to appear abundantly near the bases of the

stems. By October first, many of the branches had produced large numbers of the fruit-bodies with mature spores (Fig. 3, *c.*). These resembled in nearly every detail the specimens of *Pleonectria berolinensis*, Sacc. in Ellis and Everhart's North American Fungi, No. 470.

13. *Longitudinal section of a cluster of perithecia of Pleonectria.*

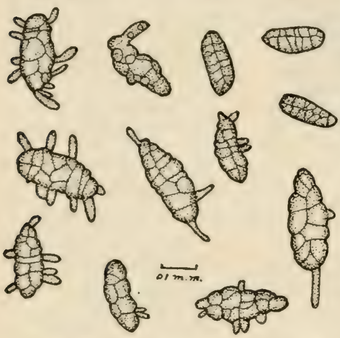
The perithecia are minute, smooth, spherical or pear-shaped bodies, and are usually borne in clusters closely crowded together. The color is brick-red or reddish-brown, bright when the plants are fresh, but duller when dry. Each cluster is usually seated upon a more or less distinct stroma, but seldom, if ever, is this a cushion of *Tubercularia*. Most of the specimens examined seem to be nearly sessile upon the wood, but an evident stroma is shown in Fig. 13. The clusters originate beneath the bark, but as they grow older and larger, they break through and appear on the surface, bordered by the ruptured edge of the epidermis. Occasionally, several clusters are joined side by side, forming a ring extending nearly around the stem. In some instances, when the bark had been torn away, the perithecia are not clustered, but entirely distinct and superficial on the wood. In such cases there is no evidence of an underlying stroma, certainly none of *Tubercularia*. When fresh the perithecia are swollen out and nearly spherical; but when old and dry the apical

14. *Longitudinal section of a single perithecium of Pleonectria.*

portion around the minute opening collapses, so that a distinct and characteristic saucer-shaped depression is produced in each.

When the interior of the perithecium is examined a condition represented in Figure 14 is found. Around the outside is a wall or shell of sterile tissue, formed by the coalescence of hyphal threads. Projecting from the bottom of this wall, and converging toward the apex, are numerous cylindrical or club-shaped sacks, the *asci*, each containing eight elliptical, colorless spores. Each spore is divided by from five to seven cross-walls into sections, many of which are further divided by walls running across the first, as represented in Figure 15. The spores measure 16–22x7–8 $\mu$. The remaining interior part of the perithecium is filled with sterile tissue.

The spores are capable of germinating under favorable conditions and reproducing the species. Numerous cultures of the ascospores were made during the fall of 1895. Growth takes place freely in both acid and neutral potato-agar. A typical culture was started December 6th. At three in the afternoon, a dilution of three plates was made in acidified potato-agar, and kept in a room where the temperature was 70-80° F. On Dec. 7th, after twenty-one hours, germination had begun.



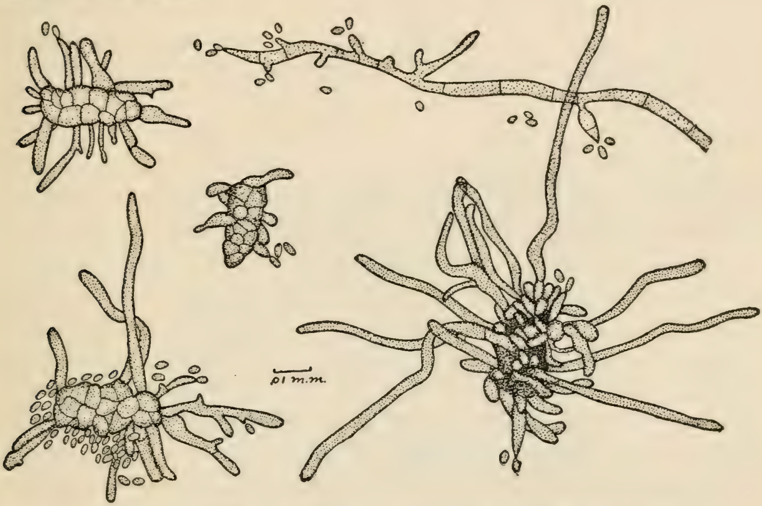

15. *Germinating spores of Pleonectria.*

The spore first swells to several times its former size through the absorption of moisture. Small protrusions then appear at various points, which elongate more or less as germ-tubes (Fig. 15). In many cases the threads, after elongating a little, begin to throw off conidia by constriction from their apices (Fig. 16). Such threads grow no further, but continue to cast off conidia in numbers. The conidia are oval in form, 4–6 $\mu$ long, and closely resemble those of *Tubercularia*, except that they are a little smaller. The other germ-tubes elongate much by apical growth, and become much branched, forming a compact mycelium. Branching begins quite early, but septa do not become numerous until the thread has attained a considerable length. No definite relation could be seen between the number of germ-tubes and the number of cells of the spore. It occasionally happened that two or three tubes came from one cell, while some cells put out none.

After the mycelium was three days old, conidia in great numbers were cast off from the sides of the threads, much as in the case of the *Tubercularia* (Fig. 16). Short lateral branches are put out, which become constricted when as long as the diameter of the thread, and the apical portion is thrown off as an elliptical conidium. This process may be continued indefinitely by the same brauch. The form of the lateral branches varies, some being long and tapering, while others are short and conical.

Innoculations were made from the plate cultures to sterilized bean stems by

touching a flamed needle into a colony containing many conidia, and touching again to the stems. The only resulting growth, at first, was a thin, sparse mycelium, which was scarcely noticeable. No white cushions were produced. After about two weeks growth, in two of the cultures, minute red points appeared. When these had increased to the size of a pin-head minute red protrusions were pushed out from the summits of several of them. When examined under the microscope, each red point was found to be a stroma composed of compact hyphae, but bearing no conidia. The protrusions presented every appearance of being forming perithecia. Unfortunately, the cultures were spoiled at this time, so that the resulting growth could not be traced.




16. *Mycelium of Pleouectria producing secondary conidia.*

Mycelium of *Pleonectria* was also innoculated to bean stems on which cultures of *Tubercularia* were growing, but the growth seemed to be in no way modified thereby.

*Innoculations.*

On May 4th, 1896, a series of innoculations of *Nectria*, *Pleonectria* and *Tubercularia* was made on currant cuttings. These were kept for a time in a forcing room in the conservatories, but were soon placed out-of-doors, after several of the plants had been attacked and killed by another fungus (*Botrytis*). About June 25th, several small, pink *Tubercularia*-like bodies appeared on two of the dead stems. These bore no conidia. Nothing has yet been produced on the living plants, nor, in the light of Mayr's experiments noted on a previous page, could results be expected in so short a time.

On the fifth of June, fresh conidia from Chautauqua county were innoculated on living currant bushes in the Horticultural grounds. An incision was made through the bark into the wood of young shoots, and portions of tubercles bearing conidia inserted. No results have yet been obtained from this experiment.

## III. REMEDIES.

We have seen that the mycelium of the fungus, after having once gained entrance to the plant, lives from year to year in the tissues of the host; that it may remain there a long time without producing any external indications of its presence; and that in this way it may be transmitted through cuttings. The first suggestion, therefore, is that all cuttings be taken from plants known to be free from the disease. It is not safe to take cuttings from apparently healthy plants in a diseased patch, but they should be obtained from localities where the disease is not present. This is the more important, since the conidia (or summer spores) exist in the soil and on the bushes, so that cuttings are liable to infection through their cut surfaces, as Mayr has pointed out. The trouble being a deeply seated one, and the conidia liable to dispersion at various seasons of the year, spraying is not to be recommended. The conidia probably do not affect entrance to the plant through healthy parts, but through cut or injured surfaces. These should, therefore, be avoided as much as possible. The only positive remedy that can be suggested is the removal of the whole plant as soon as the disease begins to be manifested in the yellow foliage and prematurely colored fruits. The diseased plants should be burned, as the spores and conidia may be produced in abundance on dead plants and the trouble communicated to living bushes.

E. J. DURAND.

**Bulletin 126.** **February, 1897.**

Cornell University Agricultural Experiment Station.

**ITHACA, N. Y.**

**ENTOMOLOGICAL DIVISION.**

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# The Currant-Stem Girdler

—AND—

# The Raspberry-Cane Maggot.

**By M. V. SLINGERLAND.**

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# BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.

# THE CURRANT-STEM GIRDLER.

*Janus integer*, Norton.*

Order HYMENOPTERA ; super-family TENTHREDINA.

The indications are that currant growers will soon have another serious enemy to combat. Most growers are already familiar with the operations of the "green worms," and many have had their bushes badly damaged by one or both of the two common currant borers, known as the imported borer and the American borer. Within the past few years, however, an insect which is both a girdler and a borer, has been attracting considerable attention by its destructive work in quite widely separated portions of the country. Unfortunately the ravages of the insect seem to be increasing each year, but fortunately a study of its habits has shown that it can be easily and quickly checked. Every currant

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*SYNONOMY.

*Cephus filicornus*. Harris' MS. catalogue. A manuscript name given by Say for a male specimen taken at Milton, Mass., in September, 1830.

*Cephus integer*. Harris' MS. catalogue. A manuscript name given by Say for a female specimen taken on a window at Cambridge, Mass., June 20, 1832.

1861. *Cephus integer* Norton. Proc. Bost. Soc. Nat. Hist., VIII, 224. First description of the insect, from Harris' specimens.

1862. *Janus flaviventris* Fitch. Seventh Rept. on N. Y. Insects, p. 852. Description of adult.

The willow-shoot saw-fly discussed by Dr. Riley as *Phyllœcus integer* Norton is doubtless another insect, *Janus abbreviatus* Say, according to Mr. Harrington (Canadian Uroceridæ, in Trans. Roy. Soc. Canada for 1893, p. 133). Dr. Riley admits that there were some differences between his specimens and Norton's description of *J. integer*.

The reference of Fitch's *J. flaviventris* as a synonym of Norton's *J. integer* was made after a careful examination and comparison (by Mr. A. D. MacGillivray) of the former's description and our bred specimens with Norton's descriptions and the original type specimen from the Harris collection. According to Know's latest generic table, the insect belongs to the genus *Janus*.

grower should therefore at once familiarize himself with the workings of this new pest, and thus be prepared to check it whenever any indications of its presence appear on his bushes.

Through the kindness of Mr. B. M. Hoag, South Easton, N. Y., in furnishing us an abundance of material, we have been enabled to breed the insect in our cages here at the insectary during the past year. Several new facts have resulted from this study of the pest ; for instance, we had the pleasure of being the first to see the insect perform the interesting operation of girdling a currant shoot. (See plate IV, figure *a*.)

## HISTORICAL.

This new currant pest is an American insect. As early as 1830, Dr. Harris captured a male specimen at Milton, Mass., and in 1832 he took a female on a window at Cambridge, Mass. Both these specimens were given different manuscript names by Say, but they were not described. Nearly thirty years passed before the insect again received any attention. In 1861 Norton wrote a description of it, evidently from Harris' specimens ; he used one of Say's names for it, and stated that it also occurred in New York state. In 1862, Dr. Fitch described the same insect under a new name ; he had captured it in May in New York state, and thought it might possibly be the insect that was boring in the rye stems.

The insect does not seem to have been mentioned in print again for a quarter of a century, or until 1888. But some of Professor Comstock's old unpublished notes show that Mr. J. F. Rose, South Byron, N. Y., had observed the work of a "new borer" in his currants in 1882. In February and April, 1883, he sent specimens of the injured shoots to Professor Comstock who succeeded in breeding the adult insect, which he determined at the time as being doubtless the insect described by Dr. Fitch in 1862. Thus these observations were the first to throw any light upon the habits of the insect, but as they were never published, it was not until 1888 that anything was recorded about any insect girdling currant shoots ; and it was not until 1891 that it was publicly

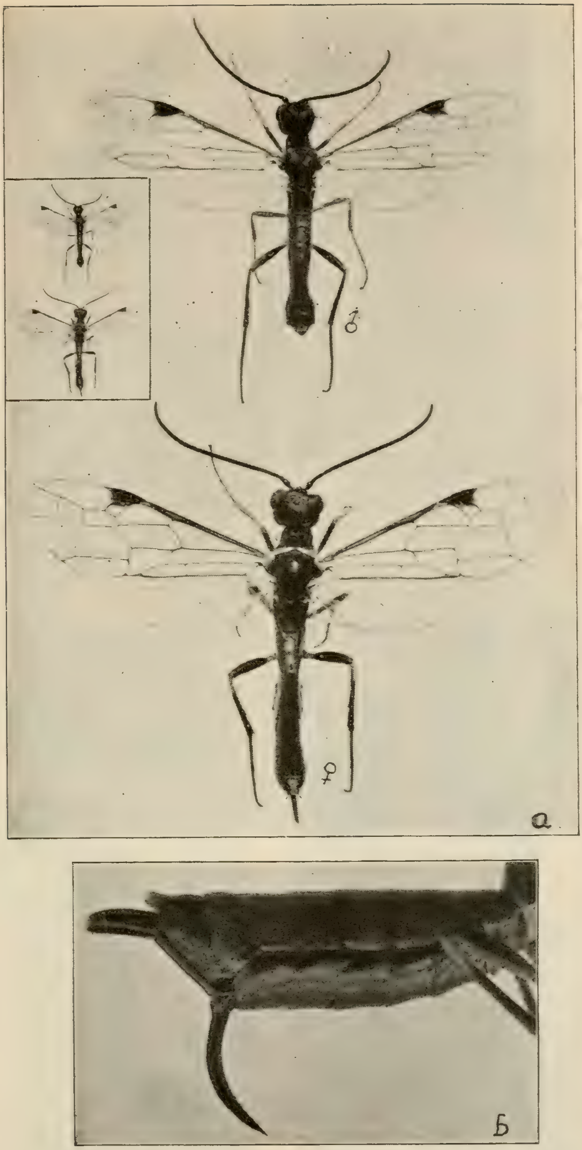


PLATE III.—a, *male and female of the currant-stem girdler (Janus integer* Norton), *much enlarged; the same are represented natural size on the left of this figure.* b, *abdomen of the female saw-fly with its saw-like ovipositor in position for ovipositing or girdling. Much enlarged.*

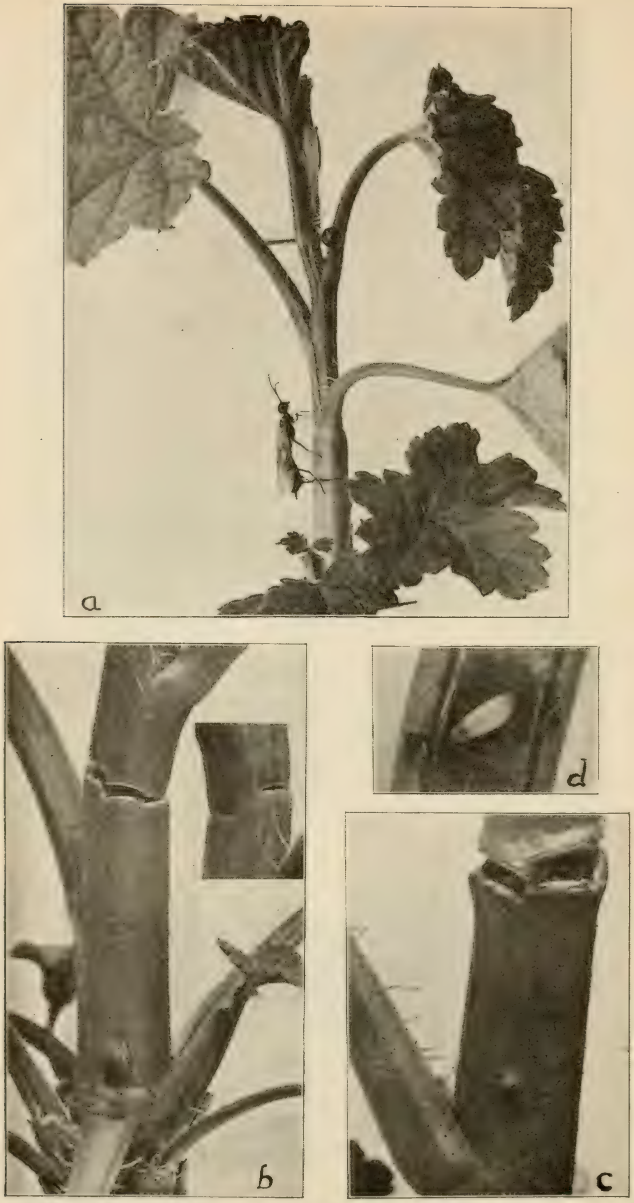


PLATE IV.—a, *the female at work girdling a currant stem, natural size;* b, *girdled portion of a stem, much enlarged, to show the character of the girdle;* c, *girdled portion of a stem a few days after the girdling was done, much enlarged, to show the egg-scar;* d, *currant stem cut open to show the egg of the insect, much enlarged.*

known that the author of this girdling was the insect described by Dr. Fitch in 1862.*

In 1886, the work of the insect was seen on currants at Adrian, Mich. In 1887, Dr. Lintner obtained specimens of injured tips from several gardens in the vicinity of Albany, N. Y., and some were sent to him from Macedon, Wayne Co., N. Y.; it was also known to occur in Canada as early as 1887. In 1891, girdled tips were found at South Byron and Chatham, N. Y. Professor Claypole recorded in 1892 that he had observed the work of the insect for several years at Akron, O. It attracted attention at Centreville, R. I., in 1892, and in 1894 the insect was quite numerous there, and also in different parts of Massachusetts. Our notes show that in 1895 considerable damage was done by the insect at South Easton, N. Y.; specimens were also sent to Dr. Lintner from Corning, N. Y.

### ITS DISTRIBUTION AND DESTRUCTIVENESS.

The above historical notes show that this currant stem-girdler was first found in Massachusetts and has since been recorded in Rhode Island, New York, Canada, Ohio and Michigan. It is quite widely distributed over New York state.

As will be shown in our discussion of the life-history of the pest, it is capable of doing much damage to currant bushes. Thus far, however, its ravages have been confined to limited localities. We have no definite data in regard to the extent of its ravages. It has attacked the Cherry and Fay's Prolific currant, and the black currant. Doubtless the insect has no choice of varieties. It probably breeds freely on the wild currants from which it has recently turned its attention to the cultivated varieties.

### INDICATIONS OF THE PRESENCE OF THE INSECT.

Observant currant growers will have no trouble in determining

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*In 1887, many currant tips were girdled in the vicinity of Albany, N. Y., and in 1888, Dr. Lintner published an account of the work of this then unknown insect. In December, 1890, Mr. Allis, Adrian, Mich., wrote to Dr. Riley that he had bred in 1887 one pair of the insects which had been girdling his currant tips as described by Dr. Lintner; in 1889 he raised another adult which was sent to Dr. Riley to name. Dr. Riley replied that the insect was without doubt Fitch's *Janus flaviventris*.

whether this stem girdler is at work on their bushes or not. The results are very conspicuous from the first, as is well shown (half natural size) in the frontispiece. In May, after the new shoots have reached a growth of several inches, two or three inches of the tips of those attacked by the insect will suddenly wilt or fall over and hang suspended or may fall to the ground. A careful examination of the shoot at the point where it broke off will show that it was deftly girdled with several sharp, somewhat curved cuts extending nearly through the stem. Figures *a*, *b*, and *c*, plate IV. illustrate this girdling process which will be discussed in detail when we tell the life-story of the insect. Sometimes where the stem is quite large or the cuts do not extend deep enough, the tip will remain upright for several days or more, but it usually wilts, dies, and breaks off later. This girdling, of course, stops all further growth of the shoot at the tip, thus disfiguring and stunting that portion of the bush for the rest of the season. This severing of the terminal shoot, is, in fact, the principal damage done by the insect. Sometimes the growth of a very thrifty shoot will be continued by one of the side buds below the girdle, as shown (half natural size) on the right of figure 17.

17.—*Currant stems as they appear in winter, after having been girdled by the insect in May. One-half natural size.*

The injured shoots can also be quite readily discovered in the winter; the three shoots shown in the left of figure 17 were cut before growth began in the spring. They show that the girdling in the preceeding May had effectually stopped all growth during the season. The characteristic dead stubs on the ends of injured shoot render them sufficiently conspicuous to be recognized by

observant currant growers in the winter. Thus one phase of the work of this insect—its girdling habit—fortunately makes it a comparatively easy matter to ascertain whether it is present in a currant plantation or not, either during the growing season or in the winter.

### THE INSECT'S APPEARANCE.

Although the insect makes its presence known in the conspicuous manner shown in the frontispiece, it is so shy that no one has ever caught the girdler at its destructive work on the bushes in the field. Thus currant growers will rarely, if ever, meet with the adult insect—the saw-fly—which does the girdling. However, many will be interested to know how the ingenious girdler looks. Both sexes are therefore shown, natural size, at the right of the much enlarged figures of the same at *a*, plate III. The insect is one of the saw-flies and is thus closely allied to the parents of the well-known "green-worms," which every currant grower has to fight almost annually. They are called saw-flies from the fact that they have a saw-like ovipositor; it is quite a formidable affair in the case of the currant stem-girdler, as figure *b*, plate III shows. The uses to which this insect puts this saw-like instrument are discussed further on.

As the figures show, the male insect is somewhat smaller than the female, and it also differs somewhat in its coloring; both are pretty little saw-flies with shining black bodies and light brownish-yellow legs. In the male, nearly all of the abdomen is of a brownish-yellow color, while in the female the first half of the abdomen is of a reddish-orange color and the rest is black. The mouth-parts, in both sexes, are of a light lemon-yellow color, and similarly colored markings occur on the thorax around the bases of the wings.* The adults fly in May, and perhaps some currant growers may be fortunate enough to see some of the shy little creatures. The other stages of the insect—its egg, the grub, and the pupa—are to be found only in the currant shoot below where it was girdled. To see them one must split open the injured shoots at certain times during the summer. These earlier stages of the

*For detailed specific descriptions of both sexes see Insect Life, VI, 300.

insect and the proper time to look for them are discussed under its life-history.

## THE STORY OF ITS LIFE AND HABITS.

*Its winter home.*—At any time during the winter this stem girdler may be found within the shoots whose tips were cut off in the preceeding May; three such shoots are shown, half natural size, on the left in figure 17. If such shoots be cut off and split open the condition shown at *a*, figure 18 will be revealed. Beginning at the tip, a tunnel will be found extending down the shoot for from four to six inches; this tunnel is always packed full of brownish excrement, as shown in the figure. Nearly three-fourths of an inch at the lower end of this tunnel will be found nicely cleaned out and lined with a thin silken cocoon. Within this cocoon inside of the injured shoots the grub or larval stage of the insect passes the winter. In the right-hand shoot at *a*, figure 18 is shown the cocoon at the lower end of the tunnel; it has been cut away in the left-hand shoot and the grub is thus revealed. At *b*, in figure 18 the lower portion of *a* is shown about two and a half times natural size. The grub or borer is of a glistening straw-yellow color, with the head slightly darker. The thoracic segments are nearly twice as wide as the head and are slightly wider than the others; they bear six rudimentary feet. From the caudal end of the body there projects upward a peculiar dark brown horny spine, slightly bifid at the tip.*

*Its spring transformation.*—The grub remains in its silken cell unchanged all winter, but when spring opens in April it changes to the curious whitish pupa shown about twice natural size between the two shoots at *b*, figure 18. In 1896, the change from a grub to a pupa took place about April 15th, and about two weeks of the insect's life was passed in the pupal condition. In our cages, the pupae began to give forth the adult insect on May 2d, and all had emerged by May 6th. As the spring of 1896 opened unusually early, the adult insects emerged earlier than

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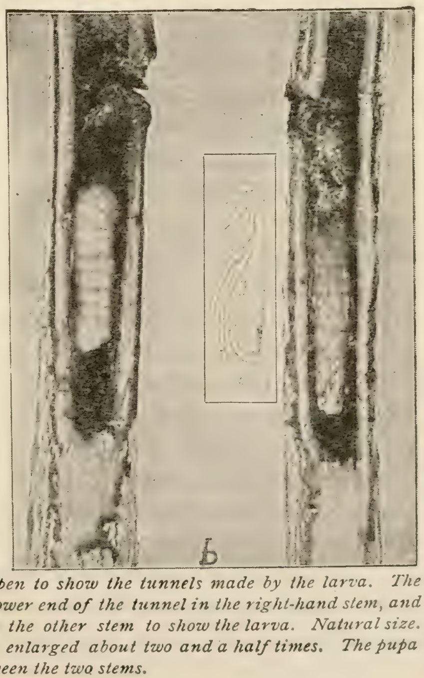
*A detailed description of the larva occurs in Bull. 28 of the Mass. (Hatch) Expt. Station; and an excellent figure of it may be found in Insect Life, VIII, p. 389.

has been recorded in previous records; from the middle to the last of May seems to be their normal period of emergence.

*Egg-laying.*—As no one had recorded any observations upon the habits of the adult insects, we were much interested to know how the female laid her egg, and why and how she girdled the currant shoots. Therefore, when a male and female emerged in one of our cages on May 2d, a special effort was made to cater to every whim they might manifest. Their "native heath" was imitated, so far as possible, by placing several freshly-cut currant shoots in a roomy cage. The pair of saw-flies were then carefully transferred to this cage. As though apparently appreciating the




18.—a, *two currant stems cut open to show the tunnels made by the larva. The cocoon is shown in the lower end of the tunnel in the right-hand stem, and it has been removed in the other stem to show the larva. Natural size.* b, *the cocoon and larva enlarged about two and a half times. The pupa is shown (enlarged) between the two stems.*

effort that had been made for her comfort, the female began laying eggs within fifteen minutes after she entered the cage. Evidently the insect sometimes begins egg-laying very soon after it emerges, for the female just mentioned had not been out of the cocoon more than two hours; we did not see the pairing of the sexes, and it may not have taken place, for as we shall see later, the female will sometimes lay unfertilized eggs.

In laying an egg, the female takes a position on the shoot a few inches from its tip, with her head towards the tip, and quickly works her long, curved, saw-like ovipositor into the shoot. At figure *b*, plate III, this ovipositor is shown much enlarged and drawn out in position for egg-laying; when not in use it is drawn upward and rests nearly out of sight in a groove in the end of the abdomen. This ovipositor is pushed or sawed in its whole length, and the egg is then quickly forced along between the two blades of the ovipositor and is deposited in the pith of the shoot, as shown much enlarged at *d*, plate IV. The ovipositor is quickly withdrawn, and the whole operation of laying an egg is accomplished in about a minute.

The egg is of an elongate-oval shape, of a yellowish-white color when first laid, about a millimeter (1–25 of an inch) in length, of a delicate structure, and without any characteristic sculpturing. In a day or two after deposition, transparent areas appear at both ends of the egg, and before hatching the whole egg loses its whitish opaque appearance and becomes transparent so that the developing grub can be plainly seen inside.

The slit cut by the ovipositor when an egg is laid is so small that it can scarcely be found even with a hand-lens until about two days after it is made. By that time nature, in her efforts to heal the wound has caused an increased growth around the slit, and there is thus a slight elevation on the shoot at that point. The egg-slit is readily seen on the lower part of the enlarged shoot shown at *c* on plate IV. Most of the eggs are doubtless laid in the latter half of May; some are not laid until June, as we received several on June 8th that had been laid only a few days.

*How and why the shoot is girdled.*—Immediately after the operation of laying an egg in the pith of the shoot is finished, the female walks up the shoot for from one-half an inch to an inch

and deliberately proceeds to girdle it. This is doubtless the most injurious of any of the insect's habits; and yet the manner in which the girdling was accomplished remained a mystery until we had the pleasure of seeing the female cut many shoots in our cages in May, 1896. Most writers have supposed that the girdling was done with the jaws of the insect, but our observations show that it is done entirely with the saw-like ovipositor.

A female is shown, natural size, in the act of girdling a currant shoot at *a*, plate IV. She first forces her ovipositor its whole length into the shoot. When she withdraws it, however, she does not pull it straight out, but twists it to one side so that it is held at right angles to the body, and then makes it saw its way out. As the ovipositor is curved, its tip first appears through the bark of the shoot off at one side from where it was forced in, and the rest of the "saw" soon comes through leaving a smooth, somewhat curved cut forming a part of the circle around the shoot equal in length to about the length of the ovipositor. The enlarged, recently cut shoot shown at *b*, plate IV, well illustrates the nature of these cuts. Without moving from her position, the female usually again inserts her ovipositor very near where she did the first time, but twists it the other way thus making two cuts extending in opposite directions from one point. She then moves around the shoot until she finds the end of one cut, and proceeds in the same manner to cut another slit. She continues this process of moving around the stem and cutting new slits from the ends of those just made, until the girdle of cuts is complete, or nearly so. We have repeatedly seen a female lay an egg in a minute and in the next four minutes girdle the shoot a short distance above the egg. Sometimes the girdling is so complete that the tip falls of at once, but usually a portion of the shoot remains uncut and the tip may remain attached for sometime, especially if the shoot is a large and vigorous one. At *b*, plate IV, the ends of the girdle did not quite meet; and in some cases the female lost her bearings to such an extent as to continue the girdle of cuts in a spiral direction so that the last cut was above and nearly an eighth of an inch from the first one. Sometimes the female did not first make two cuts from the same point, but at once moved around the stem and made the second cut at

the end of the first, and so on around. Usually four or five cuts were sufficient to girdle a shoot.

It was very interesting to watch so deft and quick a worker as this insect when she was girdling a shoot. She was not easily disturbed when once her work was begun. We have seen one female girdle four or five shoots in an hour in our cages. Of course, the number of tips one insect will girdle, depends upon how many eggs it lays. One female in our cages girdled fourteen shoots and was then accidently drowned. A careful examination revealed four more eggs in shoots that she had not girdled, and we found ten eggs in her abdomen; thus one female is capable of laying at least thirty eggs or may girdle thirty currant shoots. Much damage might thus be done by only a comparatively few of the insects in a currant plantation.

Doubtless the object of the girdling of the shoot above the egg is to cause a cessation of the growth, and thus prevent any injury which might come to the delicate egg or young grub from the vigorous growth which currant tips make in the spring. Yet in spite of this precautionary habit of the mother, many of her young never develop, as we shall see.

*Habits of the borers.*—Some of the eggs laid by the insect in our cages hatched out the grubs in about eleven days. The minute borers at once began feeding upon the pith of the stem, and tunneled their way downward in the pith, as shown in the left-hand shoot in figure 19. They seem to feed almost entirely upon the pithy part of the shoot; often enough of the woody portion remains to sustain sufficient life in the shoot to develop buds all along the sides of the tunneled portion, as shown in figures 18 and 19. The excrement voided by the borers remains in their tunnels, filling them full of a dark brownish mass, as illustrated in the same figures. If an injured shoot be split open at any time between June 1st and September 1st, the borers may be found at work within their tunnels.

*The great mortality among the eggs and young grubs.*—Our observations agree with those recorded by Mr. Marlatt (Insect Life VII., 388) in regard to the failure of many of the eggs and young borers to develop. The material sent us in the spring of 1896, indicated that not over 15 per cent of the eggs laid the preceeding

year had developed full grown borers; in most cases the eggs apparently did not hatch, as no tunnel had been begun in the pith, but in some cases the borers got nearly half grown before they succumbed. As Mr. Marlatt stated, the reason for this great mortality is not apparent. He suggested that it might be due to the fact that the cultivated currant, on account of its difference in growth or greater luxuriance, is not as suitable to the insect as wild currants or allied plants, which were presumably its original food plants.

Another explanation of this great mortality may be the fact that an unfertilized female will lay eggs and girdle the shoots as freely as any other female. We demonstrated this fact in our cages last year, but we were not able to definitely determine whether these unfertilized eggs hatched or not.

However, the fact that there is such a great mortality among the eggs and young grubs of this insect, is of but little practical importance to the currant grower, for in the girdling of the shoots, the pest does its principal injury.

19.—*Currant shoots split open to show the character of the tunnels made by the borers. One-half natural size.*

*Extent of the tunnels of the borer, and its preparations for the winter.*—The grubs begin their work of tunneling down the pith of the girdled shoot as soon as they hatch in the latter part of May. Although the borer continues to work in the pith for about three months, its tunnel rarely extends more than six inches from the point where the shoot was girdled. In one instance where three shoots branched off, as shown in figure 19, a borer tunneled down to the base of one shoot and then across the main stem and part way up another shoot, where it met its death from the attacks of one of its enemies.

About September 1st, the borer begins to make preparations for the winter and for its further transformations. It cleans out the

lower end of its burrow for the distance of about three-fourths of an inch, and also eats a passage way through the woody portion of the stem out to the outer layer of bark which soon dies and sinks in slightly at this point. This passage way is partly filled with excrement or "frass," and the grub then proceeds to spin a thin silken cocoon about itself within which it remains as a grub all winter. These winter preparations are well illustrated at *b*, in figure 18. Sometimes the small dead sunken area of bark covering the passage to the cocoon may be readily detected in winter or spring on an injured shoot. This passage-way enables the adult insect (the saw-fly), to easily make its way out from the cocoon in May.

### NATURAL ENEMIES.

The eggs embedded in the pith of the shoots, and the borers as they tunnel their way down the pith, seem to be beyond the reach of their enemies. But the necessity of eating a passage-way to the outer bark to provide for the emergence of the adult insect affords an opportunity which their little foes seem on the alert to secure. Nearly one-third of the full grown borers sent us in the spring of 1896, had been attacked and killed by tiny hymenopterous parasites, evidently after they had spun their cocoons. In every case the little foes had doubtless broken through the thin door opening into the passage-way leading to the cocoon, and had inserted their eggs into the body of their helpless victims. These eggs hatched out maggots which lived at the expense of the body of their host. When full grown the little maggots spun their silken cocoons within the larger cocoon made by the borer. In one case five of the tiny Braconid parasites (*Bracon apicatus* Prov.) emerged from one cocoon of the currant stem-girdler. Curiously enough the parasite nearest the passage-way emerged first, and the others followed in regular succession; we saw one emerge, and upon examining the cocoon next behind, found the adult parasite all ready to appear, while in the next cocoon, we found the insect still in the pupa state. It is to be hoped that this little enemy will continue its good work among the grubs of this new currant pest.

### HOW TO CONTROL THE INSECT.

The currant-stem girdler can not be reached at any time or in any stage with a spray. Fortunately, however, its habits are

such that it can be easily controlled by other means. The girdling habit of the adult insect (see the frontispiece), which causes the tips of the young shoots to wilt, die, and drop off in May, makes it easy for currant growers to determine whether the pest is present in their fields, and also just where to apply the remedy. As the egg is embedded in the shoot less than an inch below where the girdling is done, and as the grubs rarely tunnel down the pith to a depth of more than six inches, if the injured shoots be cut off at least eight inches below their tip and burned, all traces of the insect will be effectually destroyed. Only two or three inches of the tips need be cut off, if it is done in May or June, soon after the girdling is done. The cutting and burning of about eight inches of the tips of the injured shoots at any time of the year, even in winter, will prove a practical and effective remedy for this new pest.

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# THE RASPBERRY-CANE MAGGOT.

*Pho bia* sp.

Order DIPTERA ; family ANTHOMYIIDÆ.

20.—*A raspberry shoot attacked by the raspberry-cane maggot. Natural size.*

Recently a new insect pest has appeared in many raspberry plantations in New York state. It attacks the new shoots in the spring, and in one field sixty per cent of the new growth was killed by the insect in 1895. We first learned of its ravages in our state in May, 1895, when specimens were sent to the insectary from two localities in central New York, Spencer and Cortland. Raspberry plantations in the vicinity of Ithaca, N. Y., were at once examined with the result that in some cases one-third of the new shoots were being killed by the pest ; it was also nearly as destructive at Ithaca in 1896.

Raspberry growers should therefore at once familiarize themselves with the work of this new insect enemy, so as to be able to intelligently combat it whenever it may appear in their plantations.

## INDICATIONS OF THE PRESENCE OF THE INSECT.

This raspberry-cane maggot attacks only the new shoots which appear in the spring. The results of its work are very conspicuous, and raspberry growers can thus easily determine if the insect is present in their fields. Three injured shoots are represented, natural size, in figures 20 and 21. These figures show that the tips of new shoots attacked by the insect wilt and droop; the stem of this tip shrinks, turns dark blue in color and finally dies. The wilted tip may be easily broken off at a certain point. If the shoot be carefully examined at this point it will be found to have been girdled by the insect from the inside; how this girdling is done will be described in telling the life-history of this pest. Sometimes a very vigorous shoot will continue its growth from side buds, thus forming a branched cane, but usually the injury to the tip results in the death of the whole shoot. In one case the terminal tip and the tips of three of its side shoots had all been killed by the insect.

The pest begins its destructive work as soon as the shoots appear above the ground in the latter part of April, and its work continues during the whole of May. All sizes of the new shoots are attacked; those in figures 20 and 21, and at *b*, plate V, are represented natural size.

Thus when raspberry growers find the tips of new shoots wilted and drooping in May, it is an indication that this new insect pest is at work in their fields.*

## THE APPEARANCE OF THE INSECT.

Although raspberry growers will have no trouble in discovering the work of this pest, only the most careful observers will doubtless ever see the adult insect. So close is the resemblance, that the ordinary observer would say that the little flies, which may be seen on the new shoots in May, were simply house-flies. But a careful study of one of the flies, shown much enlarged at *a*

*The raspberry-cane borer (*Oberea bimaculata*, causes the tips of the growing canes to wilt and droop in a similar manner, but this insect does not begin work until considerably later, in June. Thus the work of the two insects need not be confounded in our state.

plate V, would reveal many differences. A detailed description of this fly is unnecessary here. It is a grayish-black, two-winged fly, not quite so large as, but closely resembling the well-known house-fly, of which it is a near relative.

The progeny which hatch from the eggs of flies are known as maggots. To see the young, or the maggots, of this raspberry pest, it will be necessary to carefully split open an injured shoot; in June the maggot will usually be found below the girdle in the lower portion of the shoot. The maggot is slender, white, smooth, footless, and measures from 8 to 10 mm. in length when full-grown. Its black hook-like mouth parts may be indistinctly seen through the semi-transparent skin of the head. Its blunt caudal end has around its margin several small fleshy pointed tubercles, and from the centre project the two elevated brown spiracles.

## ITS NAME.

This new raspberry pest belongs to that peculiar order of insects —the true flies—known as the *Diptera*. It is one of the Anthomyiians, and is thus closely related to the cabbage and the onion root-maggots discussed in bulletin 78. In 1886, Mr. Fletcher bred the adult insect, but did not have an expert determine its name. Others who have noticed its work have failed to get the fly. We also failed in our first attempt to breed the insect in our cages, but finally succeeded in obtaining several flies from material collected in the field early in the spring. As the females of many of these Anthomyiian flies are so near alike, it is necessary to study the males to get specific characters for determination. We sent two males to a specialist in England, Mr. R. H. Meade, but they arrived in such a mouldy condition that it was impossible to determine their name, except that they doubtless belonged to the genus *Phorbia*; this is the same genus to which the cabbage and the onion maggots belong.*

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*Mr. Meade wrote us: "The two Anthomyiids which you sent me belong to the genus *Phorbia*; but do not seem to be identical with any European species that I know of. They are so covered with mould, however, that most of their characteristic features are destroyed."

Thus this new raspberry pest may also prove to be new tc science and therefore as yet unnamed.

## HISTORICAL.

The first record we find of any maggot working in raspberry shoots is the statement of Professor Cook that he found "a maggot working in the succulent growth of a raspberry cane" in 1886, at the Agricultural College in Michigan ; this was doubtless the same insect as the raspberry-cane maggot under discussion. The next year, what was probably the same insect, was observed at work in Canada, by Mr. Fletcher ; he recorded a very brief but accurate account of its habits. In 1890–'91, a raspberry-cane maggot was seen in some West Virginia plantations. In 1894, apparently the same pest destroyed nearly half the new shoots in a raspberry field at Lansing, Mich.; and was also reported as doing considerable damage in the vicinity of Costello, Pa During the past two years it has injured a large percentage of the new shoots in the raspberry plantations of central New York ; in 1895, Dr. Lintner received many infested tips from Adams, Jefferson Co., N. Y.

## DISTRIBUTION AND FOOD-PLANTS.

From the above historical review, we learn that this new raspberry pest seems to have thus far attracted attention only in Michigan, New York, Pennsylvania and Canada. All observers report that it is apparently as yet confined to limited localities. Its spread will doubtless be rather slow ; the flies may go from one field to another, and a few of the maggots or puparia may be transported in stock shipped from infested fields. Although we have seen its work only in Tompkins, Cortland and Tioga counties in our State, yet we are quite sure, from conversations with raspberry growers, that it occurs in many other localities.

The insect works in the new shoots of both red and black raspberries, and no other food-plants have been recorded.

## THE LIFE-HISTORY OF THE INSECT.

In the latter part of April, when the new raspberry shoots are a few inches in heighth, the adult insect—the fly shown much enlarged at *a*, plate V—appears and soon begins laying eggs.

*Egg-laying.*—The comparatively large, prettily sculptured, elongate, white eggs of this pest are loosely placed near

the very tip of the shoot in the crotch formed by the bases of the tip leaves; at *c*, plate V, is shown one of the eggs much enlarged, and at *d*, are represented three eggs, natural size, in the position in which they were laid. As the fly is smaller than a house-fly, these eggs are comparatively large ones for such an insect, and would thus indicate that one female fly does not lay a large number of eggs. How soon the eggs hatch, we did not determine; it is doubtless but a few days.

*Work of the maggot.*—The little white maggot which emerges from the egg, crawls down the shoot for a short distance (less than an inch), and then burrows its way into the pith of the shoot. The entrance hole of the maggot is usually quite conspicuous, as the surrounding tissues turn blackish. After the maggot reaches the pith it proceeds to tunnel its way downward, making a small, somewhat tortuous tunnel in the pith. After tunneling about half the length of the shoot (sometimes this is six inches or more but may be only an inch or two), the maggot works its way nearly out to the bark, and deftly continues its tunnel around the shoot, thus girdling it from the inside; this interior girdle or tunnel shows well in the broken shoots at *b*, plate V. Usually the maggot eats a small hole out through the bark, at some point in the girdle; the use of this opening, we have not determined. The maggot continues feeding on the pith at the point where the girdling was done, and nearly severs the shoot in this way. The shoot in the lower right-hand corner of *b*, plate V, is represented with the bark removed to give a clearer idea of this interior girdling. Usually the maggot girdles the shoot in a spiral manner, sometimes tunneling nearly twice around, as shown on one shoot in the right-hand corner of *b*, plate V.

The part of the shoot above the girdle soon wilts, shrinks in size and droops over as is shown in figures 20 and 21. Soon after the tip droops, a dry rot begins at the girdled point, the wilted portion turns a dark blue color, and the whole shoot usually dries up and dies. Perhaps the maggot could not develop in a growing shoot, and it would also be hindered in its transformation to the adult in such a shoot. This may be the explanation why the insect girdles the shoot.


PLATE. V.—*The raspberry-cane maggot* (*Phorbia* sp.). a, *adult female fly, much enlarged;* b, *raspberry shoots girdled by the maggot, natural size;* c, *egg, much enlarged;* d, *tips of three shoots, each bearing an egg in its natural position in the crotch at the bases of the leaves, natural size.*

After thus checking the growth in May, the maggot proceeds to burrow its way downward in the pith and finally reaches the base of the shoot at or near the surface of the ground. This point is usually reached sometime in June.

*Pupation.*—By July 1st, many of the maggots had undergone a transformation in the lower end of their burrow. Their skin had hardened, turned dark brown in color, and inside this *puparium*, the insect was passing through the *pupa* stage, preparatory to becoming an adult.

Although the puparium is found in June and July, the adult insect—the fly—does not emerge until the next April. The winter is thus passed as a pupa inside the dead base of the shoot. There is but one brood of the maggots each year.


21.—*Infested raspberry shoots. Natural size.*

### NATURAL ENEMIES.

Like most of our injurious insects, this raspberry-cane maggot has its enemies among its own kind—the insects. Instead of the adult insect—the Anthomyiian fly—emerging from some of our puparia, a little four-winged hymenopterous parasite appeared. The indications are that many of the maggots fell a prey to this little enemy in 1895 and 1896. It has been determined as *Idiasta incompleta* Prov. We hope its good work may continue in our raspberry fields.

### HOW TO COMBAT IT.

With a little watchfulness this new raspberry pest may be easily checked. Its presence may be quickly detected in May, as its work is then very conspicuous; and this is the only month in

which the insect can be combated practicably and with any success. It is capable of doing much damage, especially on new and valuable varieties.

The remedy is simple. As soon as a drooping tip is seen, either pull up the shoot or cut it off several inches below the girdle and burn it. This method faithfully carried out throughout May, will quickly check the pest. There is no possible chance of getting at the insect with a spray. Simply burn all infested shoots in May.

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MARK VERNON SLINGERLAND.

**Bulletin 127.** **February, 1897.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

A SECOND ACCOUNT OF

# SWEET PEAS.



**By A. P. WYMAN and M. G. KAINS.**

PUBLISHED BY THE UNIVERSITY.

ITHACA, N. Y.

1897.

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## BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.

CORNELL UNIVERSITY, ITHACA, N. Y., Feb. 10, 1897.

*Honorable Commissioner of Agriculture, Albany.*

SIR :—The enclosed report is submitted for publication under the provisions of the Experiment Station Extension bill, and it is a complement to Bulletin 111, issued a year ago this month. This Bulletin 111 was the first experiment station report upon sweet peas. It called forth some harsh criticisms, which were very largely due, I think, to a misconception of the problem at which we were working. Our motives in its preparation were two : to popularize the sweet pea, and to give an account of the varieties which were actually sold by the dealers last year. Our estimates of varieties were often very unlike the estimates which are currently made of them ; and it was charged that many of our varieties must have been very untrue to type or else grown from very poor seed. If this charge was true, it only shows that poor seed was in the market and it is evidence enough that the test was needed. In other words, our effort was to determine the exact merits of the sweet peas commonly offered for sale, not to grow the strains of fanciers and plant-breeders. This fact was stated in the bulletin and the reader was cautioned that our estimates of the varieties were drawn solely from our local tests, as follows : "An attempt was made the past season to obtain all the sweet peas which were offered by American seedsmen. * * * The reader should remember, however, that these opinions are founded solely upon the behavior of the varieties upon our own grounds last year. They are not intended to serve as a general or infallible estimate of the varieties. The accounts of these varieties are all made directly from the plants as they grew on our grounds, uninfluenced by published descriptions."

Having grown the sweet peas of the retail seedsmen last year, we have this year turned our attention to the types and strains of the experts and breeders. It is evident, therefore, that the descriptions of this year are not comparable with those of last year ; but the sweet pea lover may be interested to study the dissimilarities in the accounts of the two seasons made from seeds from different sources. In order that there should be as great uniformity as possible in our own work of the two seasons, we have grown the peas of this year upon the same ground which

we used last year (although it was in better condition), and Mr. Wyman has again taken notes, Mr. Hutchins, C. C. Morse & Co. and the Sunset Seed and Plant Co., supplied us most generously with seeds and have been most helpful with suggestions.

It may be well to repeat that these estimates of the varieties of sweet peas are those which have been formed solely from a most careful study in the experiment patch at Ithaca. We did not make the experiment as a mere variety test, and we do not care whether anyone accepts our estimates of varieties or not. We have tried to write the truth as we have been able to see it, hoping that the record may be a contribution to the history of the evolution of the sweet pea. The lists are capable of showing the student how far the flower has been developed, and what measure of satisfaction he may expect in the growing of it. Neither are we desirous of breeding new varieties. That is not our mission, and there are others who can do it much better. We have made a record of what the flower is and what may be expected of it; and now we must hurry on, for we have lots to do.

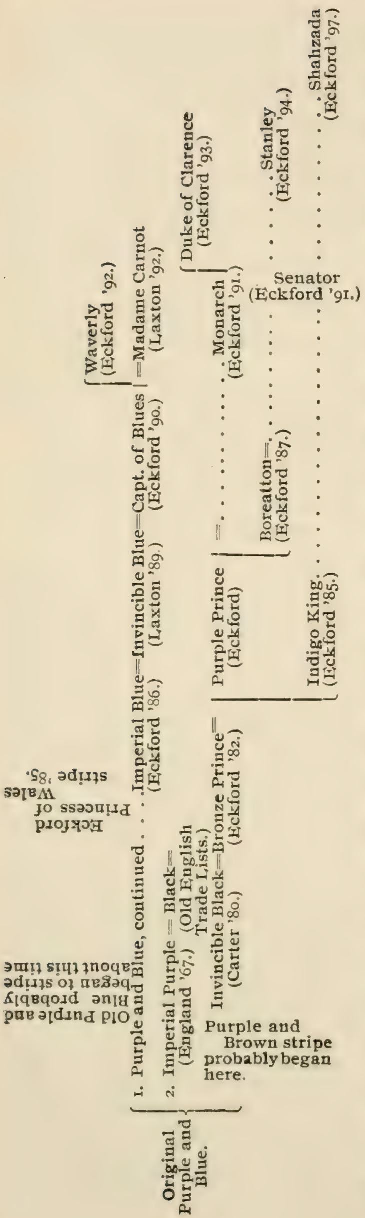
Our peas were sown April 20, upon a clay loam which is low enough to keep moist through the season. Until the plants began to bloom freely, the land was kept in a thorough state of tillage. Fig. 22 shows the plantation as it looked July 20, before the heaviest bloom had appeared. In this plantation, 176 separate samples of peas were grown. The study of these peas was put in the hands of two mature and capable students. Mr. Wyman did the greater part of the work upon the former test. During the present season he represented us at the sweet pea show at Springfield, Mass., whence we sent a collection of blooms representing the common run of the plantation. Mr. Kains is a post-graduate student in the College of Agriculture. The work of these young men has been carefully supervised, and I endorse the results, although, of course, it is impossible for any two persons to arrive at identical conclusions respecting the merits of given varieties.

We have no further information to give for the cultivation of sweet peas than was given in our former bulletin, except to say that the ground may easily be made too rich for them. Several persons complained to me last year that their sweet peas grew luxuriantly but did not bloom. They had used too freely of

stable manures, and the plants ran to vine. The sweet pea is one of that class of plants (the leguminous) which appropriates nitrogen for itself, and heavy applications of nitrogen are therefore not needed. Another type of complaints was to the effect that young plants died after having made a good growth of several inches. Inquiry revealed the fact that in every case the plants had been frequently watered from a watering pot. Just enough water had been applied to keep the surface of the ground soggy, and the plants had damped-off. Plant lovers should remember that one good watering which wets the ground clear down is worth a dozen dribblings. It is rare that a sweet pea bed should be watered oftener than once a week in good soil; and if the seeds are got in early, a frequent stirring of the surface soil with hoe or rake is better than watering at all.

In the forcing of sweet peas we have made two tests in a very small way. A year ago we sowed seeds in a bench in a chrysanthemum house on October 24, and they began to bloom Feb. 20, and continued to blossom well for six weeks. The bloom was not so profuse as it is out of doors, but the flowers were just as large and handsome and fragrant. Fig. 23 shows a corner of sweet peas as they looked early in March. We also had a most profuse bloom in a row forty feet long during last April, May and June. The seeds were sown in pots, and when chrysanthemums were taken off (from a solid bed) on December 10, the peas were turned into the soil from 2½-inch pots. They were blooming freely when sweet peas were quoted as high as carnations. Last fall we sowed seeds in the same house September 8 in a solid bed. The plants grew well, and a single truss opened on November 30. The weather then closed in for a characteristic Ithaca winter, and the sun did not shine again for a full day for two months, and no other flowers appeared until early in February. If the weather had remained bright, I see no reason why we should not have had good flowers for Christmas.

The history and something of the evolution of the sweet pea are traced in our Bulletin 111; but Rev. W. T. Hutchins, Indian Orchard, Mass., a long-time student of the flower, has given me his conception of the evolution of the modern varieties in a graphic form, which is here reproduced:




The reader of Bulletin 111 may remember that Waldo C. Rohnert, sweet pea specialist of the firm of C. C. Morse & Co., contributed a sketch of his efforts to breed varieties by crossing. The following are further remarks by him along the same line :

" Some people have no idea how hard it is to get a new variety in sweet peas, that is, new and distinct, with merit. In roguing time I can go over our fields and find 'off' plants, but they do not possess merit. The color is probably of a different shade or the form is a little different. But they are all 'off' types. New varieties are brought about only by a good deal of careful work. Last summer I spent many a day in the hot sun crossing the different varieties and in consequence have a trial ground this year that is truly odd to look at. Most of it is common Blanche Ferry and the Light Blue and Purple. It is very strange how strong the blood of these two varieties exists in the new varieties. Last year I spent a good deal of my time crossing on Cupid and obtained crosses of over thirty different varieties on this little imp. Now the result is that all varieties that have red or pink in them come a Blanche Ferry of the ordinary Blanche

Ferry growth, and all varieties that have blue in them come a Light Blue and Purple. This is always the rule when crossing on Cupid. Here and there are plants of Cupids, but these come because the crossing was not made perfectly. It is very hard to cross on Cupid as the pollen breaks away when the bud is very small. Several years ago I put Cupid on Venus and last year I got a weak Blanche Ferry of ordinary Blanche Ferry growth. Last year I put Cupid onto this cross and now I have a Cupid again. This is three-fourth Cupid blood and one-fourth Venus, and still it does not show any of the latter. It cannot be distinguished from the thousands of Cupids we have growing.

"Of the other crosses, that is, those on the taller varieties, the results are also discouraging. There are several new things, however, that save the whole summer's work from being a total failure. My stock of Penzance on Venus '95 was put onto Coquette (a plant which I found last year and a variety which Eckford will introduce in this country next year) brought me a variety with a pale pink standard and white wings. It has the grandiflora form and is very pretty. Lottie Eckford on Eliza Eckford brought me a flower like the former, but color of reddish mauve. Last year I had an 'Improved Royal Robe.' It was a result of Penzance on Venus and was the finest stock on Royal Robe I ever had. This year it broke up into many new and several old varieties, but all of very fine form and color, such as buff, with a suggestion of pink, a rose edge, a pink edge on white ground (Eckford's Countess of Aberdeen), a pink edge on buff ground; there are fine shades of white, also improved Ovids, Royal Robes, Lady Penzance, Blushing Beauty, etc. It is truly the finest mixture in sweet peas; there is not a flower of poor form or color in it. We will also have for next year's introduction a pink which will correspond to Grey Friar. It is better than the latter, as the color in much finer."

It is hoped that this bulletin may contribute something to the joy of rural life by interesting persons who have a rod of land to spare, in the delights of plants and the restfulness of nature-study.

L. H. BAILEY.

22.—*The Cornell sweet pea patch, July 20, 1896*

# A SECOND ACCOUNT OF SWEET PEAS.

## I. Notes upon Sweet Peas (*A. P. Wyman*).

Someone asked Mr. Burpee at the Springfield Sweet Pea Show what are the important points to be observed in judging the value of varieties of sweet peas. He replied by quoting from Eckford, but arranged his points in different order : "form, size, substance, and color." He, of course, looked at the matter from the seedsman's point of view. To him commercially, color was the least thing to be considered. The general observer would see color only, and experience only a vague satisfaction or dissatisfaction if the other points were not what they should be. But Mr. Burpee had good ground for putting color last, for this, tolerably sure to be good anyway, is absolutely worthless unless placed on a canvass suited to receive it.

The various forms which the sweet pea assumes easily fall into four classes. One class is the large flower which bends and curls its standard forward into a hood, like the Countess of Radnor. Another large flower, as Gaiety, spreads itself out into a broad, round, expanded form, but without a stiff effect. Still another bends or reflexes the sides of its banner backward in a manner not so pleasing, and if the substance is poor, in a manner which is almost ugly as in Fairy Queen. Last, there is the stiff, erect blossom, the smallest type, from which all the varieties have sprung, as Carmen Sylva. In connection with this expansion and hooded character and reflection, must be considered the shape of the base of the standard. In the last or old natural form, and to a greater or less extent in the reflexed, the base is wedge-shaped. In such case, the banner cannot help falling backward, because there is no structure to pull it forward into place. In the expanded and hooded forms, the base is different. Here it is not only straight horizontally or truncate, but in the hooded form is drawn down, giving an ear-like or auriculate shape. This explains the characters of the two expanded and hooded classes. The broad truncate base is stiff and pulls the edge of the blossom forward tightly into place, or if it is auriculate, it is still stronger, and curls the edge still farther forward into a hood. There are

two other variations which cannot be classified and which occur in the poorer forms only, as a rule. These are the occurrence of a notch at the top, or really the emphasis of a minute notch already there, as in Emily Henderson, or else a notch or sinus at either or both sides of the standard, as in the case of the Butterfly.

Three sizes are commonly accepted and will be found accompanying the classification above. The small, as in Captain Clarke, is that of the old natural form. The medium size is the one usually found in the reflexed form, like the Boreatton. While the large size of Senator and Dorothy Tennant is that of the expanded and hooded classes.

Substance, that is, the quality of texture which enables the flower to retain its shape, has arbitrarily been put under the heads of good, fair, and poor. Those varieties which keep their blossoms fresh and rigid in the heat of midday are called of good substance. Those whose blossoms curl and wrinkle badly are called poor, and the fair are various degrees between. The value of substance as affecting the beauty of the flower is not appreciated until one gives close study to the sweet pea. A flower without good substance or texture is absolutely ugly. Without strong substance it would appear that expansion and hooded character could not remain, and the flower would fall back into the reflexed class where, with its large size, it would curl and wrinkle until, in the lowest types, the flowers become worthless.

It is now possible to give the characteristics of the four classes into which most varieties of sweet peas seem to fall. This idea of classifying them was suggested by Mr. Hutchins, who based his classes upon the shape of the base, and the degree of substance or size which would result therefrom. A full statement of these classes, as they seem to work out from the studies of the Cornell tests, is as follows :*

I. The old natural form, with a wedge-shaped base, erect, expanded standard, and small size, as Delight and Carmen Sylva.

II. The reflexed form, with a more or less wedge-shaped base, the standard with its sides more or less curled backward or re-

* Another classification is given in the "Sweet Pea Review" of the Sunset Seed and Plant Co., San Francisco,—a booklet which is invaluable to anyone who desires full descriptions of varieties.

flexed, of medium size, and of substance rarely good, as Firefly, and Fairy Queen.

III. The expanded form, with a truncate or somewhat auriculate base, a broad, erect, rounded standard, large size, and fair to good substance, as Gaiety and Ovid.

IV. The hooded form, with an auriculate base, a hooded or half-hooded standard, large size, and fair to good substance, as Her Majesty and Emily Eckford.

These classes, of course, are not divided by hard and fast lines, but no variety in the experiment has yet been found which either did not fall or tend to fall into one of them.

We are now, perhaps, better prepared to understand Mr. Burpee's preference in putting color last in the scale of points. It is because form brings with it a number of other qualities, all of which make a flower a good one or a poor one. There is, however, a deeper reason for this preference for form which it would need an artist to explain. The eye is as much pleased with beauty of form as with color. The mere outline of a blaze of light carries with it a certain effect. Ruskin tells us that the old Gothic windows in the best days of Gothic architecture owed their characteristic beauty to the form of the aperture in which the stained glass was placed and not to the decorations about that aperture. It would seem to be the same with the sweet pea. Unless there is a full blaze of light from a full rounded curve, the effect in part is lost. Then, too, the variations in light and shade in the complexity of the flower are no small addition to the complete rounded effect. Last, the blossom must be large enough to be appreciated, but still not so large as to lose that delicacy which is one of its greatest charms.

The variety of color which is to be found in the sweet pea is wonderful. Since the four original varieties were sent out, numerous additions, to say nothing of improvements, have been made. At the same time, there are a few stock types, about which the others cluster. If one wishes to enjoy the best of all there is in the sweet pea without growing what would appear to be an amateur variety test, it can easily be done by selecting the best representative of each type of color and growing them and them only. All classes and colors may be easily divided into

nine types each of which has a general characteristic of its own. By beginning with the dark purples, a graduation may be made to the whites, and from the whites again on to the bright reds. The dark purples may be taken as the first class, represented by Waverly. The striped purples may be considered second, of which Senator is an example. The lavenders may be called third, represented by the Countess of Radnor. The whites come fourth, of which Blanche Burpee and Emily Henderson are the most famous. The primroses, as Mrs. Eckford, may be counted fifth. Sixth come the white shaded with pink, as Blushing Beauty. Seventh are the striped pinks, as Mrs. Joseph Chamberlain. The orange pinks are eighth, as Lady Penzance and Meteor. Last are the rose pinks, which may be subdivided, one class a pure pink, as Her Majesty and Royal Robe, the other having orange besides the rose, as Firefly and Miss Hunt. Here is wide range of color, and of a high quality, all gained by simply growing nine or ten varieties of sweet peas. Respecting double sweet peas, it may be said that the doubles are generally strong strains and give a profusion of large bloom, most of which, fortunately, is single.

It is a great advantage, of course, in the purchase of anything to know just what to get, and when a wise man purchases, he gets the very best. At the Springfield Show, Mr. Hutchins and Mr. Burpee selected independently the four varieties which each considered the best. Mr. Hutchins' choice was, Her Majesty, Mrs. Eckford, Lady Penzance, Ramona. Mr. Burpee's choice agreed with this as to the first two, Her Majesty and Mrs. Eckford, but chose for the others, Mrs. Joseph Chamberlain and Blanche Burpee. A selection by either of these men, of course, carries much weight, but when they agree upon any one or two varieties as being the best of all, their choice is not to be disputed. Besides this, the Station experiment plot has been closely studied and the best representatives in all points of each of the classes which have been named above as they have grown here this summer, have been recorded. They are (in my opinion) :—

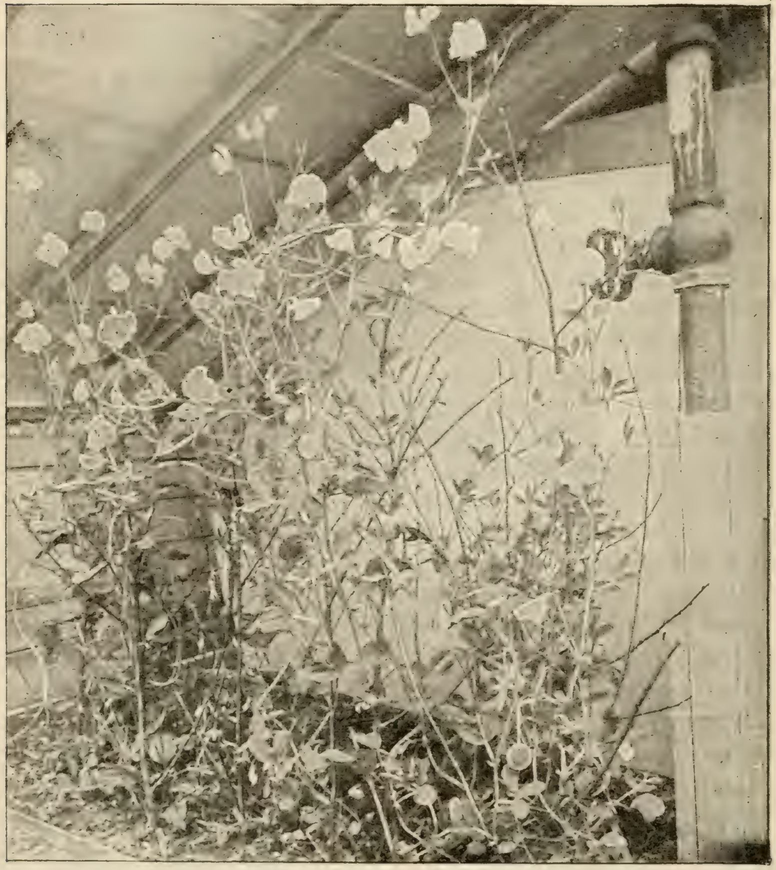
| | |
|---|---|
| I. Dark purple. | 1. Waverly. |
| | 2. Duke of Clarence. |
| II. Striped purple. | 1. Gray Friar. |
| | 2. Juanita. |
| | 3. Senator. |

| | | | |
|---|---|---|---|
| III. | Lavender. | 1. | Countess of Radnor. |
| | | 2. | Lottie Eckford. |
| IV. | White. | 1. | The Bride. |
| | | 2. | Emily Henderson. |
| V. | Primrose. | 1. | Mrs. Eckford. |
| VI. | White flushed with pink. | 1. | Blushing Beauty. |
| | | 2. | Katherine Tracy. |
| | | 3. | Eliza Eckford. |
| VII. | Striped or flaked pink. | 1. | Ramona. |
| | | 2. | Mrs. Joseph Chamberlain. |
| VIII. | Orange-pink. | 1. | Lady Penzance. |
| | | 2. | Meteor. |
| IX. | Rose-pink. | 1. | Her Majesty. |
| | | 2. | Splendor. |
| IXa. | Rose-pink shaded with orange. | 1. | Firefly. |
| | | 2. | Princess Victoria. |

These results are simply those of this experiment plot. Blanche Burpee, I suppose, ought to have come before Emily Henderson in the whites, but it has not come up to expectation here and consequently must drop out. No doubt the same is true of other varieties. Nevertheless we hope that in this list is the cream of most that is good in sweet peas. It is said that Emily Henderson is inferior to Blanche Burpee because it is notched, does not spread so freely, curls or reflexes to some extent, and has a tinge of green as the latter does not. Nevertheless, with us Blanche Burpee is not a useful flower. While full grown individual blossoms possess all the qualities said of it, most of the flowers do not spread or else fade before maturity, and consequently do not act the part expected of them. Of the striped pinks, Ramona and Mrs. Joseph Chamberlain ought really not to be compared, as they are of a wholly different shade of pink. Ramona may be put first only because it is perhaps the more refined. Mention of the dwarf Cupid must not be omitted. Cupid is not wholly a thing of beauty; Mr. Hutchins, however, considers it well worth the introduction historically. He wants it as the basis of future crosses with the tall varieties, that one may be enabled to procure the blossoms at a more convenient height.

I am greatly indebted to Mr. Hutchins for the time and patience spent with me over the flowers at the Springfield Sweet Pea Show. The flowers certainly deserve the work and enthusiasm which Mr. Hutchins has given to them. Although careless and

free, they are the product of much labor and thought. Their requirements, while not burdensome, are exacting. The earliest springtime is none too early for them to see the ground. They are sown deep or shallow according to the character of the soil, but so that their roots will be cool. They require the full sunshine to warm them, fertility to feed them, and rain to give them drink. Given these amenities, the sweet pea becomes the pride of the garden and the joy of the home.



23.—*Sweet peas in winter.* (See page 65.)

## II. DESCRIPTIONS OF THE VARIETIES GROWN AT CORNELL IN 1896. (*A. P. Wyman* and *M. G. Kains.*)

NOTE.—These descriptions were made by Mr. Wyman directly from the Cornell patch in 1896, independently of former descriptions or others' opinions. When his notes were completed, they were placed in Mr. Kains' hands and he was asked to go over the plantation carefully and make whatever comments he thought proper. His comments are placed after Mr. Wyman's and are marked by a dagger (†). It will be noticed that the two men sometimes disagree widely as to the merits of varieties,—a fact which shows how futile it is to try to make any dogmatic assertions upon the merits of plants.

The name in parenthesis is that of the party who supplied us with the seeds. The asterisks (*) denote the Eckfords, and the year of introduction follows in some cases.

It is very probable that climate and season have much to do with the merits of sweet peas. Varieties which were "off" with us, or of mixed type, may have come from the best of seed.

The term "cropper" is used by florists to designate those plants or varieties which produce a heavy yield or crop at a certain time and thereafter flower very little or none. L. H. B.

*Adonis.* (Morse.)

Poor; reflexed; medium size; poor substance; color rose-pink; bloom medium-profuse.

Height Aug. 6, six feet.

Said to be poorest of that color.

† Profuse bloomer, mid to late season.

*Adonis.* (Hutchins.)

Same as Adonis (Morse.)

*Alba Magnifica.* (Morse.)

Fair; expanded, notched, wings at a large angle; medium size; fair-good substance; color white; bloom medium-profuse.

Height Aug. 6, six feet.

† Best all round white in plantation. Better bloomer than Blanch Burpee or Bride, but has too short stems.

*Alba Magnifica.* (Hutchins.)

Same as Alba Magnifica (Morse.)

† A little better bloomer and has longer stems than above.

*Alice Eckford.* (Breck.)* 1896.

Good; reflexed, notched; large; fair substance; color, white lightly flushed with pink; bloom medium-profuse.

Height Aug. 6, five feet.

† With us like Lemon Queen. Buds greenish yellow; standard same tint when first opened, changing to the pinkish hue.

*America.* (Morse.)

Fair; expanded, notched; medium size; poor substance; color, heavily streaked crimson; bloom profuse.

Height Aug. 6, six feet, six inches.

† Crimson and white streaked. Has more crimson than Gaiety, Mrs. Jos. Chamberlain, Queen of the Isles or Red and White Striped, with which it forms a series. Mrs. Chamberlain is the lightest in color.

*American Belle.* (Breck.)

Is Apple Blossom.

*Apple Blossom.* (Morse.)*

Good; hooded; large size; good substance; color varies between purplish rose and light purplish pink; bloom profuse.

Height Aug. 6, six feet.

A standard. Would be "very good" if true to type.

† Variable, particularly in wings. Liable to be mottled. Mottling seems to be a seasonal defect or due to fertilizer. See *American Florist*, July 18, 1896, p. 1330.

*Apple Blossom*, double. (Burpee.)

Very good; hooded; large; good substance; color rose pink; bloom sparse-medium.

Height Aug. 6, four feet, six inches.

Occasionally double.

A good strain of Apple Blossom.

*Black.* (Morse.)

Poor; reflexed, notched; medium size; poor substance; color, claret, wings purple; bloom medium.

Height Aug. 6, five feet, six inches.

† Bloom profuse toward end of season. Poor at best.

*Black and Brown Striped.* (Breck.)

Poor; expanded or reflexed, notched; medium size; very poor substance; color, streaked claret, wings streaked reddish purple; bloom medium.

Height Aug. 6, five feet.

† Large size as a rule. Not an attractive variety.

*Black Purple.* (Breck.)

Is the Black.

*Blanche Burpee.* (Morse.)* 1895.

Good; expanded or reflexed; medium-large size; fair–good substance; pure white; bloom medium profuse.

Height Aug. 6, three feet, six inches.

Is a disappointment; produced very few fully expanded blossoms, those, however, of good quality.

† Size variable; substance, poor. Wings crumpled, unlike other whites in this respect. Larger than Alba Magnifica; poor bloomer.

*Blanche Burpee.* (Hutchins.)* 1895.

Same as Blanche Burpee (Morse).

† A little better than preceding.

*Blanche Burpee.* (S. S. P. Co).* 1895.

Same as Blanche Burpee (Morse).

Height August 6, three feet.

† Largest and best formed white in plantation; better than the preceding; would rank it first of the whites if a better bloomer.

*Blanche Ferry.* (Morse.)

Fair; expanded, notched, bold; medium size; fair substance; color, standard crimson rose, wings rose purple, shaded or blotched on white in various degrees; bloom profuse.

Height Aug. 6, six feet.

† An early "cropper," much mottled this year. See *American Florist*, July 18, 1896, p. 1330. Burpee's illustration on seed packets shows white wings. Very little white in our patch.

*Blushing Beauty.* (Morse.)* 1893.

Very good; hooded; large; good substance; color, delicate pink; bloom medium.

Height Aug. 6, four feet, six inches.

Has a little more color than Alice Eckford.

† A favorite; one of the best pinks.

*Blushing Beauty.* (S. S. & P. Co.)* 1893.

Same as Blushing Beauty (Morse).

Height Aug. 6, two feet, nine inches.

*Blushing Bride.* (Breck.)

Is Blanche Ferry.

*Boreatton.* (Morse.)*

Fair; reflexed; medium size; poor substance; color, claret, wings purple; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

† Very poor substance. Bloom profuse toward close of season. Cannot distinguish from Stanley.

*Boreatton.* (Hutchins.)*

Same as Boreatton (Morse).

*Boreatton.* (S. S. & P. Co.)*

Same as Boreatton (Morse).

Height Aug. 6, four feet, six inches.

*Boreatton*, double. (Burpee.)

Very good; expanded; large size; fair substance; color, claret, wings purple; bloom sparse.

Height Aug. 6, four feet.

Did not double.

Same as Boreatton, of better size and substance.

†Some few doubles—both in wings and standard. Has more purple than single Boreatton.

*Bride, The.* (Lynch.)

Very good; expanded; large; fair-good substance; color, pure white; bloom medium.

Height Aug. 6, five feet.

† About the same size as Blanche Burpee, but wings not crumpled. Poorer bloomer than Blanche Burpee.

*Bronze King.* (Morse.)

Fair ; expanded, somewhat reflexed ; medium size ; poor substance ; color white flushed or strongly blotched with a coppery hue, wings white or blotched with rose purple ; bloom medium.

Height Aug. 6, six feet, six inches.

*Butterfly.* (Morse.)

Good ; hooded, with sinuses at the sides ; medium size ; good substance ; color white edged with mauve, flushed with lavender ; bloom medium–profuse.

Height Aug. 6, five feet.

*Butterfly*, double. (Burpee.)

Good ; hooded, with sinuses ; medium size ; fair substance ; has a little more color than Butterfly ; bloom medium.

Height Aug 6, four feet, two inches.

Did not double.

† Only a few doubles.

*Butterfly Improved.* (Morse.)

Good ; hooded, sometimes with sinuses ; large ; fair–good substance ; has less color than Butterfly ; bloom medium.

Height Aug. 6, five feet, three inches.

Sinuses less than in Butterfly.

*Butterfly Winged.* (Morse.)

Good ; hooded, sometimes with sinuses ; large ; fair–good substance ; has more pink than Butterfly ; bloom profuse.

Height Aug. 6, five feet, six inches.

Wings curl separately.

Light Blue and Purple intermingled.

*Captain Sharkey.* (Breck.)

Like Invincible Carmine.

*Captain Clarke.* (Morse.)

Poor ; expanded, erect, slightly notched, wings at a large angle ; small ; fair substance ; color, white unevenly flushed with carmine, penciled with mauve, wings lavender ; bloom medium-profuse.

Height Aug. 6, five feet, six inches.

*Captain Clarke.* (Hutchins.)

Same as Captain Clarke (Morse).

*Captain of the Blues.* (Morse.)*

Good ; expanded, erect ; large ; fair-good substance ; color, purple-magenta, wings purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

*Captivation.* (Breck.)* 1896.

Good ; expanded ; medium size ; fair-good substance ; color, light pinkish purple ; wings rose-purple.

In bud Aug. 3 ; had three blossoms Aug. 7.

Height Aug. 6, three feet.

† Larger than medium ; late.

*Cardinal.* (Morse.)*

Fair; expanded, erect; medium-large size; poor substance; color, crimson-rose inclined to be blotched, wings purple-rose; bloom profuse.

Height Aug. 6, six feet.

† Small to medium. Cannot see difference between this and Capt. Sharkey.

*Cardinal.* (S. S. & P. Co.)*

Same as Cardinal (Morse), except the stock seemed to be poorer.

*Carmen Sylva.* (Hutchins).

Poor; expanded, erect, notched; small to medium size; poor-fair substance; color, white shaded with magenta, penciled with mauve, wings pinkish mauve; bloom medium-profuse; ugly.

Height Aug. 6, five feet, six inches.

† Very poor.

*Carmine Invincible.* (Morse.)

Fair; expanded; large; poor-fair substance; color crimson, wings purple-rose; bloom profuse.

Height Aug. 6, five feet, six inches.

† Distinct from Invincible Carmine.

*Countess of Aberdeen.* (Breck.)* 1896.

Not in bloom Aug. 3.

Height Aug. 6, five feet.

† No bloom Sept. 9.

*Countess of Radnor.* (Morse.)*

Very good; hooded; large; good substance; color, pinkish lavender; bloom medium. Said to be running back to original blush tint.

Height Aug. 6, five feet, six inches.

† Very large. Bloom more profuse toward end of season. Handsome and distinct. See note under Dorothy Tennant.

*Countess of Radnor.* (S. S. & P. Co.)*

Like Princess May. A striped-purple intermingled.

*Countess of Radnor Improved.* (Morse.)

Same as Countess of Radnor. Madame Carnot intermingled.

*Crown Jewel.* (Breck.)* 1896.

Not in bud Aug. 3.

Height Aug. 6, four feet, six inches.

† Very poor; erect, notched; small to very small size; very poor substance, color, blush-pink with more or less bronzy finish on the standard. Bloom sparse.

*Crown Princess of Russia.* (Morse.)

Poor; expanded; small-medium size; poor substance; color, white lightly flushed with pink and primrose, wings flushed with pink; bloom sparse-medium.

Height Aug. 6, five feet, six inches.

Said to have a historical value only as being the first of the flushed pinks.

*Cupid.* (Introd. by Burpee, 1896. See Bull. 111, p. 182).

An interesting dwarf, growing about eight inches high, and worth growing as a pot plant, but of little value in the open. The flowers are small and white, and with us were scattered along through the season, at no time making a show. See page 73.

*Daybreak.* (Morse.)

Fair ; broadly expanded or reflexed, notched ; medium size ; poor substance, color, white clouded on the back with purplish rose, less clouded on front, with white margins, giving watered effect, wings white, occasionally blotched with rose-purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

Duchess of Edinburgh intermingled.

*Daybreak.* (Hutchins.)

Same as Daybreak (Morse), but unmixed type.

*Delight.* (Morse.)*

Fair ; expanded ; small ; fair substance ; color, white with a very light shade of suffused carmine ; bloom profuse.

Height Aug. 6, six feet.

† Poor.

*Dorothy Tennant.* (Morse.)* 1892.

Very good ; hooded ; large ; good substance ; color, pinkish lavender ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

† Much like Countess of Radnor, but a shade darker.

*Dorothy Tennant.* (S. S. & P. Co.)* 1892.

Like Dorothy Tennant (Morse).

Height Aug. 6 three feet.

*Duchess of Edinburgh.* (Morse.)*

Fair ; reflexed ; medium size ; poor substance ; color scarlet and rose, wings magenta ; bloom medium-profuse.

Height Aug. 5, four feet, three inches.

*Duchess of York.* (Morse.)* 1895.

Fair ; expanded or somewhat hooded ; large ; poor-fair substance ; color, white delicately flushed and streaked with purplish pink ; bloom sparse.

Height Aug. 6, four feet.

† Very poor bloomer.

*Duchess of York.* (S. S. & P. Co.)* 1895.

Like Duchess of York (Morse).

Height Aug. 6, four feet.

*Duke of Clarence.* (Morse.)* 1893.

Very good ; expanded, sometimes hooded ; large ; fair-good substance ; color claret, wings purple ; bloom medium.

Height Aug. 6, four feet, three inches.

Said to be the finest purple.

† Handsomest and largest purple in the patch.

*Duke of Clarence*, double. (Burpee.)

Very good ; hooded ; large ; good substance ; color claret, wings dark rose purple ; bloom sparse.

Height Aug. 6, five feet.

Did not double.

† Much like Boreatton but has more of a purple effect. Fully two-fifths of the blooms are double.

*Duke of York.* (Morse.)* 1895.

Poor ; expanded or reflexed, notched ; medium size ; poor-fair substance ; color, wine, wings rose purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

*Duke of York.* (Hutchins.)* 1895.

Same as Duke of York (Morse), except that Captain of the Blues is intermingled.

*Duke of York.* (S. S. & P. Co.)* 1895.

Same as Duke of York (Morse), except that the bloom is sparse.

Height Aug. 6, four feet.

*Eliza Eckford.* (Hutchins.)* 1895.

Very good ; hooded ; large ; good substance ; color white, more or less delicately flushed and shaded with rose, back strongly flaked with rose ; bloom profuse.

Height Aug. 6, six feet.

† Very handsome, and a favorite.

*Emily Eckford.* (Morse)* 1893.

Good ; hooded ; large ; good substance ; color, pinkish lavender ; bloom sparse.

Height Aug. 6, five feet.

Said that on the third day, the flowers have nearest to blue of any sweet pea.

† Very much like Countess of Radnor, but a poor bloomer.

*Emily Henderson.* (Morse.)

Good ; expanded, sometimes reflexed, notched, wings at a large angle ; small-medium size ; fair-good substance ; color, white with a greenish tinge ; bloom medium-profuse.

Height Aug. 6, four feet, three inches.

† Poorer bloomer than Alba Magnifica, and not so good a white, but has better stems. Appears like Queen of England but a poorer bloomer.

*Emily Henderson.* (Hutchins.)

Failed to germinate well.

† One seed grew. Same as above, but had smaller stems.

*Emily Henderson.* (S. S. & P. Co.)

Like Emily Henderson (Morse), except that the bloom is sparse.

Height Aug. 6, three feet, three inches.

† Smallest white in the patch ; not like two preceding.

*Empress of India.* (Morse)*

Is Blanche Ferry.

*Etna.* (Hutchins.)

Poor ; expanded, notched ; medium size ; poor substance ; color, purplish crimson, badly blotched, with darker center and light edges, wings rose purple ; bloom medium.

Height Aug. 6, five feet, six inches.

*Fairy Queen.* (Morse.)

Poor ; reflexed, wings at a large angle ; small-medium size ; poor substance ; color, white with carmine veins ; bloom medium-profuse.

Height Aug. 6, five feet.

*Firefly.* (Morse.)* 1893.

Very good; reflexed; medium size; fair substance; color, bright rose pink, sometimes inclined to blotch, wings rose purple; bloom medium.

Height Aug. 6, four feet, six inches.

Not first-class in all points, but best of its kind.

† Pretty, but not large or stable enough. An early "cropper."

*Firefly.* (Hutchins.)* 1893.

Same as Firefly (Morse), except that the bloom is profuse.

*Firefly.* (S. S. & P. Co.)* 1893.

Like Firefly (Morse.)

Height Aug. 6, four feet, three inches.

*Firefly, Hooded.* (Morse.)

Very good; expanded, tends to hood; large; fair substance; color, rose-pink; bloom medium.

Height Aug. 6, four feet, three inches.

Larger and better substance than Firefly.

Said to be same as Mars.

*Gaiety.* (Morse.)* 1893.

Good; expanded; medium-large size; poor-fair substance; color, white streaked with purplish rose; bloom profuse.

Height Aug. 6, four feet, six inches.

† The prettiest streaked bloom in the patch. More purple than the other streaked reds. (See note under America.)

*Gaiety.* (S. S. & P. Co.)* 1893.

Like Gaiety (Morse.)

Height Aug. 6, four feet.

*Gray Friar.* (Morse.)

Very good; expanded, slightly hooded; large; fair substance; color, white watered more or less with streaked red purple giving a grayish effect; bloom profuse.

Height Aug. 6, four feet, nine inches.

Evidently sported somewhat.

Purple Prince intermingled.

*Harvard.* (Breck.)

Is Ignea.

*Her Majesty.* (Morse.)* 1892.

Very good; hooded; large; good substance; color, soft rose pink; bloom profuse.

Height Aug. 6, six feet.

*Ignea.* (Morse.)* 1893.

Good; expanded; medium size; fair substance; color, crimson pink, wings purple rose; bloom sparse.

Height Aug. 6, six feet.

*Ignea.* (S. S. & P. Co.)* 1892.

Like Ignea (Morse.)

*Imperial Blue.* (Morse.)*

Is Madame Carnot.

† Poorer bloomer than Madam Carnot.

*Invincible Blue.* (Hutchins.) Saxton, 1881.

Good; somewhat reflexed; large; fair-good substance; color claret, wings purple; bloom medium.

Height Aug. 6, six feet, four inches.

† Medium in quality.

*Invincible Black.* (Hutchins.)

Good; hooded; large; substance fair-good; color, claret, wings purple bloom profuse.

Height Aug. 6, six feet.

*Invincible Carmine.* (Hutchins.)

Fair; reflexed; medium size; poor substance; color, crimson-rose more or less blotched, wings purple rose; bloom profuse.

Height Aug. 6, six feet.

Said to be practically Cardinal.

† Distinct from Carmine Invincible.

*Invincible Scarlet.* (Breck.)

Belongs with Invincible Carmine.

*Indigo King.* (Morse.)*

Good; hooded, sinuses at the sides; large; good substance; color, claret, wings purple; bloom medium-profuse.

Height Aug. 6, six feet, three inches.

† Much like Mad. Carnot; color not so uniform; sinuses more constant and pronounced. Finer flower than Madame Carnot.

*Isa Eckford.* (Morse.)*

Poor; expanded, notched; medium size; poor substance; color, white flushed with pink; bloom medium.

Height Aug. 6, five feet, three inches.

*Isa Eckford.* (Hutchins.)*

Same as Isa Eckford (Morse.)

*Johanna Theresa.* (Breck.)

Is Light Blue and Purple.

*Juanita.* (Morse.)

Very good; expanded; large; good substance; color, white streaked and shaded with pinkish lavender; bloom medium-profuse.

Height Aug. 6, four feet, three inches.

A poor white intermixed.

† Only good; lacks character.

*Katherine Tracy.* (Ferry.)

Very good; expanded, notched; medium size; good substance; color, shaded pink, bloom medium.

Height Aug. 6, four feet.

† Large size; poor bloomer, prettiest blush-pink in patch.

*Katherine Tracy.* (S. S. & P. Co.)

Like Katherine Tracy (Ferry.)

† Somewhat better than above; deeper in tint, and a better bloomer.

*Lady Beaconsfield.* (Morse.)* 1894.

Fair; expanded, notched; medium size; poor-fair substance; color, primrose, slightly flushed with purple-rose, wings lavender; bloom sparse-medium.

Height Aug. 6, five feet.

*Lady Beaconsfield.* (Hutchins.)* 1894.

Same as Lady Beaconsfield (Morse.)

*Lady Beaconsfield.* (S. S. & P. Co.)* 1894.

Like Lady Beaconsfield (Morse.)

*Lady Penzance.* (Morse)* 1894.

Good; expanded, variously curled; medium size; fair substance; color, rose-pink with a slightly orange tint; bloom medium.

Height Aug. 6, five feet, three inches.

Stems tend to bend.

*Lady Penzance.* (S. S. & P. Co.)* 1894.

Same as Lady Penzance (Morse.)

*Lemon Queen.* (Morse.)* 1892.

Very good; expanded, notched; large; fair substance; color, white delicately shaded with purple-rose more or less suffused; bloom sparse-medium.

Height Aug. 6, five feet, three inches.

† Medium size; looks like Alice Eckford.

*Light Blue and Purple.* (Morse.)

Poor; reflexed; medium size; very poor substance; color, claret somewhat blotched, wings reddish purple; bloom sparse-medium.

Height Aug. 6, five feet, nine inches.

† Same as Black, except that the wings are a shade or so darker purple.

*Little Dorritt.* (Breck.)* 1896.

Aug. 3, has not budded.

† No bloom up to Sept. 9.

*Lottie Eckford.* (Morse.)*

Very good; hooded; large; fair-good substance; color, white edged and lightly shaded with lavender; bloom profuse.

Height Aug. 6, five feet, three inches.

New Lottie Eckford is the only Lottie Eckford now on the market.

† Excellent and distinct.

*Lottie Eckford.* (S. S. & P. Co.)*

Like Lottle Eckford (Morse.)

*Lottie Eckford Improved.* (Hutchins.)

Same as Lottie Eckford (Morse.)

Captain Clarke intermingled.

*Madame Carnot.* (Hutchins.)

Fair; hooded, sometimes with sinuses at the sides; medium size; fair substance; color, rose-mauve, wings purple; bloom profuse.

Height Aug. 6, six feet, six inches.

† Poor, even for a purple. The poorest sweet pea color; not so good as Indigo King, which might be Mad. C. improved.

*Madame Carnot.* (Burpee.)

Same as Madame Carnot (Hutchins.)

Senator intermingled.

*Meteor.* (Morse.)* 1895.

Good; reflexed or expanded; medium size; poor substance; color, orange-pink, wings soft rose pink; bloom sparse-medium.

Height Aug. 6, four feet, eight inches.

† Only medium in quality.

*Meteor.* (S. S. & P. Co.)* 1895.

Same as Meteor (Morse.)

Height Aug. 6, three feet.

*Mikado.* (Breck.)* 1896.

Seed did not germinate.

*Miss Hunt.* (Morse.)*

Fair; expanded; medium size; poor; fair substance; color, rose pink; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

*Monarch.* (Morse.)*

Good; somewhat hooded; large; substance medium-good; color, claret wings purple; bloom sparse-medium.

Height Aug. 6, four feet, six inches.

*Mrs. Eckford.* (Morse.)* 1892.

Very good; expanded; large; good substance; color, primrose; bloom medium.

Height Aug. 6, four feet, nine inches.

† Finest of the yellow whites.

*Mrs. Eckford.* (Hutchins.)* 1892.

Same as Mrs. Eckford (Morse.)

Waverly intermingled.

*Mrs. Eckford.* (S. S. & P. Co.)* 1892.

Same as Mrs. Eckford (Morse.)

Height Aug. 6, three feet.

Aug. 4, one bloom.

*Mrs. Gladstone.**

Good; expanded; medium size; fair substance; color, white flushed and shaded with purple pink; bloom sparse-medium.

Height Aug. 6, four feet.

† Large size; poor bloomer; pink.

*Mrs. Joseph Chamberlain.* (Hutchins.)* 1895.

Very good; hooded; large; good substance; color, striped purplish ros on white ground; bloom sparse-medium.

Height Aug. 6, four feet, three inches.

† Bloom better toward close of season, but then only medium. Lightest of the striped reds. (See note under America.)

*Mrs. Joseph Chamberlain.* (S. S. & P. Co.)* 1895.

Aug. 4, not in bloom.

Height Aug. 6, one foot, six inches,

† Did not bloom.

*Mrs. Sankey.* (Morse.)*

Good; hooded; medium-large size; good substance; color, white lightly shaded with purplish pink; bloom sparse-medium.

Height Aug. 6, five feet.

† Poor bloomer.

*Nellie Jaynes.* (Hutchins.)

Is Painted Lady.

*New Sunset.* (S. S. & P. Co.)

Aug. 3, not yet budded.

Height Aug. 6, three feet.

† Did not bloom.

*Novelty.* (Hutchins.)* 1895.

Fair; expanded, notched; medium-large size; poor substance; color, orange pink, wings rose pink; bloom medium.

Height Aug. 6, four feet, three inches.

† Poor.

*Oddity.* (Morse.)

Very good; hooded; large; good substance; color, light rose pink; bloom profuse,

Height Aug. 6, four feet, three inches.

† Ground color, "light rose pink" with more or less conspicuous veining of deeper pink. Poor towards close of season.

*Orange Prince.* (Morse.)*

Fair; erect, expanded; small; fair substance; color, orange-pink, wings, rose pink.

Height Aug. 6, four feet.

Aug. 3, in bud.

Aug. 6, five blossoms.

† Very poor bloomer.

*Ovid.* (Morse.)* 1894.

Good; expanded; large; fair-good substance; color, rose pink; bloom sparse.

Height Aug. 6, four feet, six inches.

† Very poor bloomer.

*Ovid.* (S. S. & P. Co.)* 1894.

Same as Ovid (Morse.)

Height Aug. 6, three feet.

*Painted Lady.* (Morse.)

Poor; reflexed, notched; medium size; very poor substance; color, crimson and rose, wings rose purple, blotched more or less with white; bloom medium.

Height Aug. 6, four feet, nine inches.

Lemon Queen intermingled.

*Peach Blossom.* (Hutchins.)* 1894.

Good; expanded; medium size; fair substance; color, white shaded with purplish rose; bloom medium.

Height Aug. 6, four feet, three inches.

Said to be hard to grow, but that the difficulty may be overcome by planting thin.

† Only medium in merit.

*Peach Blossom.* (S. S. & P. Co.)* 1894.

No bloom Aug. 4.

Height Aug. 6, three feet, nine inches.

*Primrose.* (Morse.)*

Fair; expanded, notched; medium size; fair substance; color primrose yellow; bloom medium.

Height Aug. 6, four feet, three inches.

† Medium but constant bloomer.

*Primrose.* (Hutchins.)*

Same as Primrose (Morse.)

*Princess Beatrice.* (Morse.)

Good; expanded; medium-large size;; good substance; color, shaded pink; bloom medium.

Height Aug. 6, five feet.

*Princess Beatrice.* (S. S. & P. Co.)

Same as Princess Beatrice (Morse), except that the bloom is sparse.

Height Aug. 6, four feet, three inches.

*Princess Louise.* (Morse.)

Is Violet Queen.

*Princess May.* (Hutchins.)

Good; hooded; medium size; good substance; color, pink lavender; bloom sparse.

Height Aug. 6, four feet, three inches.

† Very poor bloomer.

*Princess Victoria.* (Morse.)*

Good; expanded, notched; medium-large size; fair substance; color, light crimson, wings purple rose; bloom sparse.

Height Aug. 6, four feet, six inches.

† Closely resembles Blanche Ferry.

*Princess Victoria.* (Hutchins.)*

Like Princess Victoria (Morse), except that the substance is not so good.

*Princess of Wales.* (Morse.)*

Good; expanded; large; fair substance; color, striped red mauve; bloom, medium.

Height Aug. 6, four feet, six inches.

† Very good for a striped flower. Looks like Black and Brown Striped; unattractive.

*Purple Brown Striped.* (Morse.)

Poor; reflexed, sometimes notched; medium size; poor substance; color, striped red mauve, wings striped purple; bloom sparse-medium.

Height Aug. 6, four feet, three inches.

† Large ; same as Black and Brown Striped, except that this is a little better bloomer ; either this, or the seed is mixed. Flowers in two patches exactly correspond.

*Purple Prince.* (Morse.)*

Fair ; expanded ; large ; poor-fair substance ; color red mauve, wings purple ; bloom sparse-medium.

Height Aug. 6, four feet six inches.

*The Queen.* (Hutchins.)*

Poor ; reflexed ; medium size ; poor substance ; color, light rose pink blotched, wings purple pink ; bloom very sparse.

Height Aug. 6, three feet nine inches.

† Very poor all round.

*Improved Queen.* (Morse.)

Mixed Lemon Queen and Senator.

*Queen of England.* (Morse.)*

Fair ; expanded, notched, sometimes with sinuses ; medium size ; fair substance ; color white ; bloom sparse.

Height Aug. 6, three feet nine inches.

† Blooms better toward close of season ; medium ; looks like Emily Henderson, but is a much better bloomer.

*Queen of the Isles.* (Morse.)*

Fair ; reflexed, notched ; medium size ; poor substance ; color, rose crimson striped on white ground, wings striped magenta ; bloom medium-profuse.

Height Aug. 6, four feet, nine inches.

† Looks like Red and White Striped.

*Queen of the Isles.* (S. S. & P. Co.)*

Same as Queen of the Isles (Morse.)

*Ramona* (Morse.)

Very good ; somewhat hooded ; large ; good substance ; color daintily splashed rose purple on white ground ; bloom medium.

Height Aug. 6, four feet, three inches.

*Red and White Striped.* (Breck.)

Poor ; reflexed, notched ; medium size ; poor-fair substance ; color, striped rose crimson, wings striped magenta ; bloom sparse-medium.

Height Aug. 6, four feet, six inches.

Is Scarlet Striped.

*Rising Sun.*

Poor ; reflexed, notched, wings at a large angle ; medium size ; poor-fair substance ; color, light pink shaded to orange rose at center, wings rose purple ; bloom medium.

Height Aug. 6, four feet, nine inches.

† Poor bloomer.

*Royal Robe.* (Hutchins.)* 1894.

Very good; expanded; large; good substance; color pink; bloom very sparse.

Height Aug. 6, four feet, three inches.

Aug. 3, in bud.

† Bloom sparse; size and substance medium.

*Royal Robe.* (S. S. & P. Co.)* 1894.

Same as Royal Robe (Hutchins.)

† Not so good a sample as Royal Robe (Hutchins.)

*Scarlet Invincible.* (Hutchins.)

Fair; reflexed; medium-large size; poor substance; color, bright crimson rose; wings rose-purple; bloom sparse.

Height Aug. 6, five feet.

† Closely resembles Blanche Ferry, but darker, if anything.

*Senator.* (Morse.)*

Very good; expanded; large substance; color, striped red purple; bloom sparse.

Height Aug. 6, five feet.

† Same as Black and Brown Striped in appearance, but is a poorer bloomer.

*Senator.* (S. S. & P. Co.)*

Same as Senator (Morse.)

Height Aug. 6, four feet.

*Senator*, double. (Burpee.)

Very good; expanded; large size; good-fair substance; color, striped purple; bloom sparse.

Height Aug. 6, five feet.

† Poor bloomer; a few doubles.

*Splendid Lilac.* (Morse.)

Poor; reflexed, notched, wings at a large angle; medium size; poor substance; color, shaded carmine, wings lavender; bloom profuse.

Height Aug. 6, four feet, nine inches.

*Splendor.* (Morse.)*

Very good; hooded; large; good substance; color, rose-pink; bloom profuse.

Height Aug. 6, five feet, three inches.

† Occasional doubles; very poor bloomer at close of season. It is a "cropper."

*Splendor.* (Hutchins.)*

Same as Splendor (Morse.)

*Splendor.* (S. S. & P. Co.)*

Same as Splendor (Morse.)

Height Aug. 6, two feet, four inches.

*Splendor*, double. (Burpee.)

Very good; hooded; large; good substance; color, rose-pink; bloom sparse.

Height Aug. 6, five feet, three inches.

Doubled somewhat ; mixed with Butterfly.

*Stanley.* (Morse.)* 1894.

Good ; expanded ; large ; fair substance ; color, dark rich rose maroon ; bloom medium-profuse.

Height Aug. 6, five feet.

† Looks like Boreatton.

*Stanley.* (Hutchins.)* 1894.

Same as Stanley (Morse.)

Etna intermingled.

*Stanley.* (S. S. & P. Co.)* 1894.

Same as Stanley (Morse.)

*Venus.* (Morse.)* 1893.

Very good ; hooded ; large ; fair-good substance ; color, white lightly flushed with pink-purple ; bloom sparse.

Height Aug. 6, three feet, nine inches.

*Venus.* (S. S. & P. Co.)* 1893.

Same as Venus (Morse.)

*Vesuvius.* (Morse.)

Poor ; reflexed, wings at large angle ; poor substance ; color, light purple shaded toward center ; wings rose-purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

† Small and poor.

*Violet Queen.* (Hutchins.)*

Poor ; reflexed ; medium size ; poor-fair substance ; color, white shaded with carmine, wings pink-lavender ; bloom medium.

Height Aug. 6, four feet, six inches.

† Size and substance poor.

*Waverly.* (Morse.)* 1892.

Very good ; somewhat hooded ; large ; good substance ; color, rose-claret, wings purple ; bloom medium.

Height Aug. 6, four feet, six inches.

† Very handsome for a purple ; the best of its color ; compares very favorably with Duke of Clarence ; room for both in purples.

*Waverly.* (Hutchins.)* 1892.

Same as Waverly (Morse.)

*White Double.* (Burpee.)

Fair ; hooded, sinused ; medium size ; fair-good substance ; color white ; bloom very sparse.

Height Aug. 6, three feet, nine inches.

Did not double.

† Very poor bloomer.

## III. NUMERICAL NOTES ON THE SWEET PEAS.

(*M. G. Kains.*)

The sweet pea is always attractive. In all its varied forms and tints it is the same dainty charmer. There is no ugly sweet pea. It is, therefore, perhaps unfortunate that the words "poor" and "medium" are used; and that dates and figures, which have always an air of business, range themselves against such innocent victims. But in all variety studies some standard has to be adopted and even the sweet pea must submit. In estimating the attributes of a variety the popular scale of ten is used. A composite ideal is formed by choosing one variety as a standard of size, another of substance, and so on; then comparing the variety to be judged with this norm.

In the following table the name of the variety, and, in parentheses, the name of the grower are given. Then follow the date of first bloom, the season at which each variety was at its best on our grounds—early, medium or late—and the date of the last bloom. There were a few isolated blossoms after October 10, but the frosts of the eighth and ninth had reaped their harvest and the blooming season was past. After the date column, follow the height in feet, the length of stems in inches; then, on the scale of ten, the estimates on general productiveness of bloom and of seed, on relative size, and substance of flower.

In a collection of ten varieties the following might be chosen:

Blushing Beauty,
Apple Blossom,
Countess of Radnor, or Dorothy Tennant (substitute),
Duke of Clarence, or Waverly (substitute),
Boreatton,
Eliza Eckford, or Katherine Tracy if it were a better bloomer,
Mrs. Eckford,
Ramona,
Gray Friar,

and for a white either Queen of England or Alba Magnifica. Neither of these whites is equal in merit to those in the above list, but none of the whites are. These two have the least number of bad points.

| Name. | 1st Bloom. | Season. | Last Bloom. | Height, ft. | Length of stems, in. | Quantity of Bloom. | Production of seed. | Size. | Substance. |
|---|---|---|---|---|---|---|---|---|---|
| Adonis (Morse) ......... | July 15 | M.-L. | Oct. 10 | 7 | 7 | 8 | 3 | 5 | 4 |
| Adonis (Hutchins)...... | July 10 | M.-L. | Oct. 10 | 6 | 6 | 7 | 6 | 5 | 4 |
| Alba Magnifica (Morse).. | July 10 | E.-L. | Oct. 10 | 6 | 3 | 8 | 6 | 6 | 6 |
| Alba Magnifica (Hutchins) .................. | July 10 | E.-L. | Oct. 10 | 6 | 5 | 7 | 9 | 7 | 6 |
| Alice Eckford (Breck)... | July 18 | Mid. | Oct. 10 | 5 | 7 | 5 | 5 | 8 | 6 |
| America (Morse)........ | July 13 | E.-M. | Oct. 10 | 6 | 6 | 9 | 7 | 7 | 4 |
| American Belle (Breck). | July 10 | Mid. | Oct. 10 | 7 | 6 | 7 | 7 | 10 | 9 |
| Apple Blossom (Morse).. | July 10 | Mid. | Oct. 10 | 6 | 4 | 4 | 6 | 10 | 9 |
| Apple Blossom Double (Burpee)............. | July 10 | Mid. | Oct. 10 | 6 | 8 | 8 | 6 | 9 | 9 |
| Black (Morse).. ........ | July 12 | M-L. | Oct. 10 | 7 | 9 | 9 | 2 | 5 | 4 |
| Black and Brown Striped (Breck)............., | July 12 | E.-M. | Sept. 5 | 6 | 7 | 8 | 6 | 6 | 6 |
| Black Purple (Breck).... | July 9 | M.-L, | Sept. 5 | 6 | 9 | 8 | 3 | 5 | 4 |
| Blanche Burpee (Morse), | July 15 | Mid. | Sept. 5 | 3 | 3 | 7 | 4 | 6 | 4 |
| Blanche Burpee (Hutchins).................. | July 11 | Mid. | Sept. 5 | 5 | 5 | 7 | 3 | 8 | 6 |
| Blanche Ferry (Morse)... | June 30 | Earliest | Sept. 5 | 6 | 4 | 7 | 9 | 6 | 6 |
| Blushing Beauty (Morse) | July 14 | Mid. | Oct. 10 | 5 | 7 | 7 | 4 | 9 | 8 |
| Blushing Bride (Breck). | July 1 | Early | Sept. 12 | 6 | 9 | 7 | 4 | 7 | 6 |
| Boreatton (Morse)....... | July 13 | Late | Oct. 10 | 5 | 8 | 8 | 4 | 6 | 3 |
| Boreatton (Hutchins)... | July 13 | Late | Oct. 10 | 6 | 8 | 8 | 4 | 6 | 3 |
| Boreatton Double (Burpee) .... ............. | July 30 | Late | Oct. 10 | 5 | 7 | 6 | 7 | 7 | 6 |
| The Bride (Lynch)...... | July 14 | Mid. | Oct. 10 | 5 | 5 | 6 | 4 | 8 | 7 |
| Bronze King (Morse).... | July 12 | Mid. | Oct. 10 | 6 | 3 | 4 | 3 | 5 | 5 |
| Butterfly (Morse)........ | July 9 | Mid. | Oct. 10 | 5 | 6 | 6 | 5 | 8 | 7 |
| Butterfly (Burpee)....... | July 14 | Mid. | Oct. 10 | 5 | 8 | 7 | 6 | 7 | 7 |
| Butterfly Improved (Morse) ............. | July 14 | Mid. | Sept. 28 | 7 | 4 | 7 | 8 | 7 | 7 |
| Butterfly Winged (Morse). | July 14 | Mid. | Sept. 28 | 6 | 9 | 10 | 6 | 9 | 9 |
| Captain Sharkey (Breck). | July 9 | Mid. | Oct. 10 | 6 | 2 | 7 | 5 | 4 | 6 |
| Captain Clark (Morse)... | July 8 | Early | Oct. 10 | 6 | 9 | 8 | 5 | 4 | 5 |
| Captain Clark (Hutchins). | July 8 | Early | Oct. 10 | 5 | 3 | 8 | 4 | 4 | 5 |
| Captain of the Blues (Morse)............... | July 12 | Mid. | Oct. 10 | 5 | 3 | 4 | 2 | 7 | 7 |
| Captivation (Breck)..... | July 29 | Late | Oct. 10 | 4 | 9 | 4 | 7 | 7 | 7 |
| Cardinal (Morse)........ | June 30 | Early | Sept. 12 | 8 | 8 | 10 | 8 | 6 | 4 |
| Carmen Sylva (Hutchins). | July 15 | Mid. | Oct. 10 | 7 | 4 | 7 | 6 | 4 | 5 |
| Carmine Invincible (Morse)............ .. | July 10 | Mid. | Oct. 10 | 6 | 6 | 8 | 5 | 6 | 5 |
| Countess of Aberdeen (Breck)............... | — | — | — | 5 | — | — | — | — | — |
| Countess of Radnor (Morse)............... | July 13 | Mid. | Oct. 10 | 7 | 8 | 9 | 4 | 10 | 9 |
| Countess of Radnor Improved (Morse)........ | July 14 | Mid. | Oct. 10 | 7 | 6 | 4 | 2 | 10 | 9 |
| Crown Jewell (Breck)... | Aug. 31 | Late | Oct. 10 | 4 | — | — | — | 2 | 2 |
| Crown Princess of Prussia (Morse).... .......... | July 15 | Mid. | Oct. 10 | 6 | 4 | 5 | 2 | 3 | 3 |

| Name. | 1st Bloom. | Season. | Last Bloom. | Height, ft. | Length of stems, in. | Quantity of bloom. | Production of seed. | Size. | Substance. |
|---|---|---|---|---|---|---|---|---|---|
| Daybreak (Morse) | July 13 | Mid. | Oct. 10 | 4 | 4 | 3 | 2 | 5 | 4 |
| Daybreak (Hutchins) | July 11 | Mid. | Oct. 10 | 6 | 5 | 5 | 4 | 5 | 4 |
| Delight (Morse) | July 13 | Mid. | Oct. 10 | 7 | 4 | 6 | 4 | 3 | 4 |
| Dorothy Tennant (Morse) | July 12 | M.-L. | Oct. 10 | 6 | 6 | 4 | 3 | 9 | 8 |
| Duchess of Edinburgh (Morse) | July 12 | Mid. | Sept. 22 | 7 | 3 | 7 | 4 | 5 | 4 |
| Duchess of York (Morse) | July 22 | Mid. | Sept. 22 | 4 | 3 | 4 | 4 | 7 | 6 |
| Duke of Clarence)Morse) | July 16 | Mid. | Oct. 10 | 5 | 7 | 6 | 5 | 8 | 7 |
| Duke of Clarence, Double (Burpee) | July 15 | Mid. | Oct. 5 | 6 | 6 | 4 | 5 | 9 | 8 |
| Duke of York (Morse) | July 17 | Mid. | Sept. 22 | 6 | 6 | 6 | 5 | 6 | 5 |
| Duke of York (Morse) | July 16 | Mid. | Sept. 22 | 7 | 7 | 9 | 6 | 6 | 5 |
| Eliza Eckford (Hutchins) | July 15 | Mid. | Oct. 10 | 7 | 8 | 9 | 5 | 9 | 8 |
| Emily Eckford (Morse) | July 16 | Mid. | Oct. 10 | 7 | 5 | 3 | 3 | 9 | 9 |
| Emily Henderson (Morse) | July 11 | Mid. | Sept. 22 | 6 | 9 | 8 | 7 | 6 | 6 |
| Emily Henderson (Hutchins) | July 22 | Mid. | Sept. 22 | 4 | 4 | 3 | 3 | 6 | 6 |
| Empress of India (Morse) | July 16 | Early | Sept. 22 | 8 | 4 | 6 | 6 | 6 | 6 |
| Etna (Hutchins) | July 13 | Mid. | Oct. 10 | 6 | 4 | 6 | 5 | 5 | 4 |
| Fairy Queen (Morse) | July 10 | Mid. | Oct. 10 | 6 | 4 | 7 | 3 | 6 | 5 |
| Firefly (Morse) | July 18 | Mid. | Sept. 12 | 6 | 8 | 8 | 4 | 7 | 6 |
| Firefly (Hutchins) | July 14 | Mid. | Sept. 12 | 7 | 7 | 8 | 3 | 7 | 6 |
| Firefly, Hooded (Morse) | July 14 | Mid. | Oct. 10 | 6 | 7 | 6 | 3 | 10 | 6 |
| Gaiety (Morse) | July 14 | Mid. | Oct. 10 | 6 | 4 | 6 | 6 | 7 | 5 |
| Gray Friar (Morse) | July 1 | Early | Sept. 12 | 6 | 9 | 6 | 8 | 9 | 6 |
| Harvard (Breck) | July 5 | Early | Sept. 22 | 7 | 6 | 8 | 8 | 6 | 5 |
| Her Majesty (Morse) | July 10 | Mid. | Sept. 22 | 6 | 7 | 8 | 8 | 9 | 8 |
| Ignea (Morse) | July 16 | Mid. | Oct. 10 | 7 | 6 | 6 | 7 | 6 | 5 |
| Imperial Blue (Morse) | July 8 | E.-L. | Oct. 5 | 8 | 6 | 8 | 8 | 6 | 5 |
| InvincibleBlue(Hutchins) | July 14 | Mid. | Oct. 5 | 8 | 6 | 8 | 9 | 6 | 6 |
| Invincible Black (Hutchins) | July 16 | Mid. | Sept. 22 | 7 | 7 | 9 | 9 | 8 | 6 |
| Invincible Carmine (Hutchins) | July 11 | Mid. | Sept. 22 | 7 | 7 | 9 | 8 | 7 | 4 |
| Invincible Scarlet (Breck) | July 1 | Early | Sept. 12 | 6 | 6 | 7 | 5 | 7 | 4 |
| Indigo King (Morse) | July 10 | Early | Sept. 22 | 6 | 7 | 8 | 6 | 7 | 7 |
| Isa Eckford (Morse) | July 16 | Mid. | Oct. 5 | 7 | 7 | 7 | 6 | 6 | 4 |
| Isa Eckford (Hutchins) | July 12 | Mid. | Oct. 5 | 5 | 7 | 6 | 5 | 6 | 4 |
| Johanna Theresa (Breck) | July 3 | Early | Sept. 22 | 6 | 6 | 8 | 6 | 6 | 3 |
| Juanita (Morse) | July 15 | Mid. | Sept. 22 | 4 | 7 | 8 | 5 | 8 | 8 |
| Katherine Tracy (Ferry) | July 16 | Mid. | Sept. 22 | 5 | 5 | 4 | 4 | 8 | 8 |
| LadyBeaconsfield(Morse) | July 18 | Late | Oct. 10 | 6 | 7 | 7 | 4 | 6 | 6 |
| LadyBeaconsfield(Hutchins) | July 14 | Late | Oct. 10 | 7 | 8 | 7 | 4 | 6 | 6 |
| Lady Penzance (Morse) | July 15 | Mid. | Oct. 5 | 6 | 6 | 8 | 5 | 7 | 6 |
| Light Blue and Purple (Morse) | July 12 | Mid. | Oct. 5 | 6 | 5 | 7 | 7 | 6 | 3 |
| Lemon Queen (Morse) | July 16 | M.-L. | Oct. 10 | 6 | 7 | 8 | 5 | 6 | 6 |
| Little Dorritt (Breck) | —— | —— | —— | 4 | —— | —— | —— | —— | —— |
| Lottie Eckford (Morse) | July 20 | Late | Oct. 10 | 6 | 6 | 7 | 8 | 9 | 7 |

| Name. | 1st Bloom. | Season. | Last Bloom. | Height, ft. | Length of stems, in. | Quantity of bloom. | Production of seed. | Size. | Substance. |
|---|---|---|---|---|---|---|---|---|---|
| Lottie Eckford (Hutchins) | July 16 | Late | Oct. 10 | 5 | 8 | 7 | 9 | 9 | 7 |
| Madame Carnot (Hutchins) | July 12 | Mid. | Oct. 5 | 6 | 5 | 9 | 8 | 6 | 5 |
| Madame Carnot (Burpee) | July 12 | Mid. | Oct. 5 | 8 | 7 | 10 | 8 | 6 | 5 |
| Meteor (Morse) | July 15 | Mid. | Sept. 22 | 7 | 6 | 9 | 5 | 5 | 3 |
| Miss Hunt (Morse) | July 14 | Mid. | Oct 10 | 5 | 6 | 7 | 6 | 6 | 6 |
| Monarch (Morse) | July 17 | Late | Oct. 10 | 5 | 7 | 8 | 6 | 10 | 7 |
| Mrs. Eckford (Morse) | July 15 | E.-L. | Oct. 10 | 6 | 9 | 9 | 4 | 10 | 9 |
| Mrs. Eckford (Hutchins) | July 14 | Early | Oct. 5 | 6 | 8 | 8 | 5 | 10 | 7 |
| Mrs. Gladstone (Morse) | July 17 | Mid. | Oct. 5 | 6 | 9 | 8 | 6 | 8 | 8 |
| Mrs. Jos. Chamberlain (Hutchins) | July 16 | Late | Oct. 10 | 5 | 8 | 8 | 6 | 9 | 8 |
| Mrs. Sankey (Morse) | July 22 | Late | Sept. 22 | 6 | 5 | 4 | 3 | 7 | 7 |
| Nellie Jaynes (Hutchins) | July 1 | Early | Sept. 28 | 7 | 4 | 9 | 10 | 6 | 6 |
| New Sunset (S.S.&P.Co.) | —— | —— | —— | 5 | — | — | — | — | — |
| Novelty (Hutchins) | July 16 | Mid. | Sept. 28 | 5 | 7 | 9 | 5 | 6 | 4 |
| Oddity (Morse) | July 16 | Early | Sept. 12 | 4 | 9 | 8 | 6 | 7 | 8 |
| Orange Prince (Morse) | July 21 | Late | Oct. 5 | 4 | 7 | 5 | 4 | 5 | 5 |
| Ovid (Morse) | July 16 | Mid. | Sept. 28 | 5 | 6 | 4 | 4 | 7 | 6 |
| Painted Lady (Morse) | July 16 | Early | Oct. 5 | 4 | 6 | 8 | 5 | 6 | 6 |
| Peach Blossom (Hutchins) | July 15 | Mid. | Sept. 28 | 6 | 8 | 8 | 6 | 6 | 6 |
| Primrose (Morse) | July 16 | Mid. | Oct. 10 | 5 | 5 | 8 | 4 | 6 | 6 |
| Primrose (Hutchins) | July 16 | Mid. | Oct. 10 | 5 | 5 | 7 | 5 | 6 | 6 |
| Princess Beatrice (Morse) | July 12 | Early | Sept. 22 | 6 | 5 | 8 | 5 | 6 | 6 |
| Princess Louise (Morse) | July 14 | Mid. | Sept. 22 | 6 | 5 | 7 | 4 | 4 | 2 |
| Princess May (Hutchins) | July 14 | Mid. | Oct. 10 | 5 | 8 | 4 | 6 | 6 | 5 |
| Princess Victoria (Morse) | July 12 | Early | Sept. 22 | 5 | 6 | 7 | 5 | 7 | 6 |
| Princess Victoria (Hutchins) | July 15 | Early | Sept. 22 | 6 | 6 | 6 | 5 | 7 | 5 |
| Princess of Wales (Morse) | July 14 | E.-M. | Sept. 12 | 5 | 6 | 8 | 5 | 9 | 7 |
| Purple Brown Striped (Morse) | July 14 | E.-M. | Sept. 12 | 4 | 6 | 7 | 7 | 9 | 7 |
| Purple Prince (Morse) | July 17 | Mid. | Sept. 28 | 6 | 7 | 7 | 6 | 7 | 7 |
| The Queen (Hutchins) | July 16 | Mid. | Oct. 10 | 5 | 6 | 6 | 4 | 5 | 5 |
| Improved Queen (Morse) | July 22 | Late | Oct. 10 | 6 | 8 | 4 | 1 | — | — |
| Queen of England (Morse) | July 17 | Mid. | Oct. 10 | 4 | 5 | 8 | 4 | 6 | 6 |
| Queen of the Isles (Morse) | July 15 | Mid. | Sept. 22 | 5 | 7 | 8 | 4 | 7 | 5 |
| Ramona (Morse) | July 16 | Mid. | Oct. 10 | 4 | 6 | 6 | 4 | 10 | 8 |
| Red and White Striped (Breck) | July 16 | Mid. | Oct. 10 | 4 | 6 | 7 | 6 | 6 | 6 |
| Rising Sun (Morse) | July 10 | Early | Sept. 12 | 5 | 5 | 6 | 7 | 6 | 6 |
| Royal Robe (Hutchins) | July 21 | Late | Oct. 10 | 6 | 5 | 6 | 5 | 5 | 5 |
| Scarlet Invincible (Hutchins) | July 16 | Mid. | Oct. 10 | 6 | 7 | 7 | 5 | 6 | 4 |
| Senator (Morse) | July 21 | Late | Oct. 10 | 6 | 6 | 6 | 4 | 10 | 9 |
| Senator, Double (Burpee) | Aug 20 | Late | Oct. 10 | 6 | 8 | 1 | 0 | 9 | 7 |
| Splendid Lilac (Morse) | July 11 | Early | Sept. 22 | 6 | 7 | 8 | 7 | 6 | 4 |
| Splendor (Morse) | July 10 | Early | Oct. 5 | 6 | 8 | 9 | 6 | 9 | 7 |
| Splendor (Hutchins) | July 11 | Early | Oct. 5 | 6 | 6 | 8 | 7 | 9 | 7 |
| Splendor, Double (Burpee) | July 30 | Late | Oct. 10 | 6 | 6 | 5 | 4 | 9 | 7 |
| Stanley (Morse) | July 14 | E.-L. | Oct. 10 | 7 | 9 | 10 | 5 | 8 | 4 |

| Name. | 1st Bloom. | Season. | Last Bloom. | Height, ft. | Length of stems, in. | Quantity of bloom. | Production of seed. | Size. | Substance. |
|---|---|---|---|---|---|---|---|---|---|
| Stanley (Hutchins) ..... | July 14 | E.-L. | Oct. 10 | 7 | 9 | 10 | 6 | 8 | 4 |
| Venus (Morse).......... | July 16 | Mid. | Oct. 10 | 6 | 8 | 6 | 3 | 8 | 7 |
| Vesuvius (Morse) ...... | July 13 | Early | Sept. 12 | 5 | 6 | 7 | 4 | 4 | 4 |
| Violet Queen (Hutchins) | July 17 | Mid. | Sept. 28 | 6 | 4 | 7 | 5 | 4 | 2 |
| Waverly (Morse)........ | July 20 | Mid. | Oct. 10 | 6 | 6 | 6 | 6 | 10 | 7 |
| Waverly (Hutchins) .... | July 10 | Mid. | Oct. 10 | 7 | 7 | 8 | 6 | 10 | 7 |
| Double White (Burpee).. | July 15 | Mid. | Oct. 10 | 4 | 7 | 6 | 7 | 6 | 5 |

**Bulletin 128.** **February, 1897.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

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A TALK ABOUT

# DAHLIAS.



By WILHELM MILLER.

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1897.

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126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
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128. A Talk about Dahlias.

CORNELL UNIVERSITY, Ithaca, N. Y., Feb. 22, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

*Sir*:—When I came to New York, now several years ago, I was interested in the dahlias which are to be seen in so many of the farm-yards. To me, coming from a newer country, the dahlia was mostly a thing of the books. At least, I had no personal interest in it, for wherever I had seen the plant growing, it had been planted in a merely incidental way as a part of some confused and impersonal garden. But in the country districts of New York it clings to the old yards like a memory; and I knew that here the plant is a survival of the dahlia passion which overspread the country a generation and more ago. If the people loved this old flower so much as to cherish it in all these years of its unpopularity and neglect, I thought that we ought to improve it and refine it and let them grow it to their heart's content. So I have looked forward to the time when I might give a summer to it, but the summers are now too full to allow of such recreation. But an opportunity finally offered. The new strains of dahlias began to be advertized. Persons interested in the cultivation of it offered to coöperate in furnishing tubers, and I found the man who could catch the spirit of the experiment. I submit the result as a bulletin under Chapter 437 of the laws of 1896.

Although Mr. Miller may not agree, I do not consider the dahlia to be the chief merit of this bulletin. The best thing in it is the personal point of view. Flower-loving is sentiment and emotion, kindled with imagination. It depends vastly more upon the person than it does upon the flower. Some persons would like to love flowers but they do not know how; and there are others who think that they love them because they know their names and how to grow them. But I suspect that no one ever really loves a flower when he is conscious of an effort to love it. When a person once places himself in full sympathy with nature and learns the art of seeing everything at its best, he is in position to reap the joy of a garden; and it really does not matter so very

much whether the plants are dahlias, sweet peas or bull-thistles.

I am convinced that the farmers need education in flowers and other incidental things quite as much as they do in wheat or potatoes, for it is the lack of cheer and color and interest about the home which is largely responsible for the dissatisfaction of the young people with the country. The moment that a farmer begins to take a living interest in some restful occupation for his leisure hours will his interest in farm life begin to grow. Now and then, therefore, we like to drop a bulletin upon his table which will come as a solace and stimulant to his leisure hours, awakening memories and opening strange lines of thought. We cannot tell him directly how to get the most comfort from the gentler things of the farm, but we can take a familiar object for a narrative and a lesson; and if the dahlia has such an established place at the farmstead, it will be a good text for our purpose.

Aside from our desire to extend flower-loving and nature-study to the country, we are under obligations to the flower-trade, which is a most valued constituent and supporter of the experiment stations. I may say that members of the trade may obtain a sketch of the varieties we grew last year by writing us for it.

A curious incident of our dahlia studies occurred in connection with the American Institute Fair in New York, at which we made an exhibit of over 200 varieties. A florists' paper said that "the only commendable feature of this stand was the great number of kinds staged." Another horticultural journal said that it was "a very extensive collection of dahlias, but the blooms were not of exhibition quality." We had not supposed that such misconception of the office of an experiment station exists amongst the makers of public opinion. Surely it is no part of the business of a station to grow plants for mere exhibition. The growers themselves can do that, and they can usually do it much better than the experiment station can. The station's mission is to simply lay the truth before the people. It can have no favorites in varieties. If it exhibits at all, it is bound to show the poor and indifferent kinds along with the good ones. It is just as useful to point out defects as it is to point out merits. In studies of varieties, the experiment station is a realist. In our dahlia patch, all the varieties were given good soil and

good care, but nothing more; and when we showed them at Philadelphia and New York we took the varieties as they run, good and poor alike. If the varieties were not satisfactory, it is easy to see where the fault lies; and there is therefore all the more need for an experiment to show the actual status of the business. We have found, as the result of considerable experimentation in various lines of floriculture, that we do not often get the best stock which the dealers have. We often receive the tag-ends. If the dealers are willing that the varieties should be judged by such plants, we have no reason to object. It is of course, perfectly natural and proper that the originator of new varieties, or the exhibition grower, should retain his best strains for his own use, and for this reason the experiment station can never hope to equal the specialists in the quality of plants, even if such were its legitimate ambition.

We made our dahlia exhibitions upon the express understanding that the flowers were not entered for competition, and they were designed—as we supposed every one would know—as an illustrative and educational display of the kinds in the market, of the range in forms and colors and other features which the flowers possess, and of what the grower may expect of the plant; and we desired to collect information for our own use. The officers of the Institute evidently caught the spirit of the exhibition, for, unknown to us, they awarded the Experiment Station a bronze medal and a diploma for "a display of 212 varieties of typical dahlias."

All these remarks are made, not as a defense, but simply to illustrate by a concrete example what an experiment station is for. Its purpose is to make records. It would clearly exceed its province if it were to grow plants primarily for "exhibition quality," and the florists would no doubt be amongst the first to object to such competition.

L. H. BAILEY.

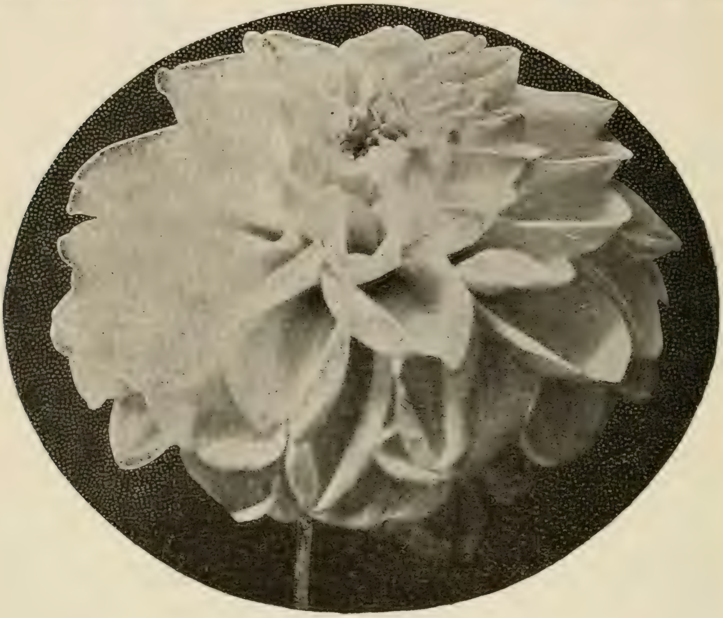
24.—*Mrs. A. Peart.* A white cactus dahlia.

# A TALK ABOUT DAHLIAS.

To very many people it will be news and scarcely credible news that dahlias have any freedom and grace of form, or any delicacy and modesty of color. The prejudice against them may never again be as strong as it is now. They are associated with a period of formalism which found its expression in highly artificial camellias, and in carnations from which the fringes,—their natural beauty—had been painfully removed by a long process of plant-breeding. The era of hoop-skirts was the time of the dahlia furore ; and what a tyrant the dahlia was! It is still remembered as a flower the size of a croquet ball, almost as hard in outline, and with colors sometimes equally coarse and gaudy. How are the mighty fallen ! The reaction against formal flowers carried the popular enthusiasm towards the loose, free, and fantastic Japanese chrysanthemums. Perhaps the deserted idol felt that the populace had gone off to strange gods. But I like to think that the poor dahlias breathed a sigh of relief when their convent days were over. They revelled in their neglect. It was bad enough to have their natural inclinations snubbed and suppressed. But it was very hard, after a period of success, to be accused of inherent primness and stiffness when those qualities were merely the result of their rigid system of education. The fault was not with the dahlias, but with the single standard of beauty that was in the minds of men. As a matter of fact the dahlia is probably able to express itself in as many wonderful and indescribable forms as the chrysanthemum is. But the dahlia has not had the chance. Chrysanthemums have been in cultivation, it is said, for over two thousand years. The double forms of the dahlia are less than a century old, and the so-called "cactus dahlias" which are going to save the whole race by their freedom and informality practically date from 1879, when the first cactus dahlia was exhibited and pictured in England. We already have many forms (Figs.

24, 32) which are surprisingly like some of the chrysanthemums, but the evolution of the dahlia is only just begun.

*A brief history of the dahlia.*—The first dahlias seen in Europe grew in the Botanical Gardens at Madrid in 1789. The seeds were sent from Mexico. The flowers were very much like that of Fig.



25. —*Miss May Lomas.* A large-flowered variety.

27, *i. e.* they had eight rays disposed in a single circle around the yellow disc. In 1814, the first double forms were produced at Louvain, Holland, after three years' work. All members of the composite family that have been through the process of doubling and have enough flexibility to entitle them to extended cultivation exhibit at least three strongly marked tendencies. One tendency is to reproduce the single forms (Fig. 27). This habit can be easily fixed and flowers of this type are called single varieties. Another tendency is toward the production of very large globular flowers that are completely double, as in Fig. 25. These large-flowering varieties are the hardest to produce and the hardest to maintain. They are always prized most highly because

the element of human skill is very large. A third tendency is toward what are called pompons. These are dwarf plants with spherical and double flowers like the last but much smaller and much more abundant. The single varieties are the most natural; the large-flowering and pompon varieties are in a larger measure the products of art. The dahlia was held pretty rigorously to these old and familiar lines of development, and unfortunately these somewhat conventional and artificial forms are still popularly supposed to be essential to the nature of the dahlia. The first double forms came to England in the winter of 1814, and in 1826 there were already sixty varieties cultivated by the Royal Horticultural Society. In 1841 one English dealer had over twelve hundred varieties.

This is a wonderful variation for a plant that had been in cultivation practically only twenty-seven years. Many other species have been in cultivation for more than a quarter of a century before showing any signs of "breaking the type" *i. e.* making a pronounced variation from their wild form. It also gives some hint of the extraordinary range of color, for the dahlia was permitted to display its color charms in but three forms, the single, the pompon or small sphere, and the big sphere of the large-flowering varieties.

In the forties and fifties variegated flowers were in great demand. Dahlias were striped, banded, speckled, penciled, dotted, blotched, and marked in all sorts of curious ways. There was as much ingenuity in the invention of these unstable compounds as is now displayed in designs for wall paper and oil cloths. These things were catalogued under the "Fancy" class, for the English divide the large-flowering varieties into "Show" and "Fancy." The "Show" section contains the "selfs," that is those varieties each of which has but a single color. The varieties of popular flowers that have unity of color-effect are usually longest lived; those having mixed color-effects are usually more unstable and are dropped out of cultivation when the popular enthusiasm goes elsewhere.

In the evolution of the dahlia too much attention has been paid to color and not enough to form. Those twelve hundred varieties of 1841 were too much like twelve hundred variously painted balls

of two sizes. How much better would it be to have thirty pure, distinct, single colors in forty different forms of expression !

There was not a single new or original idea in the evolution of the dahlia until 1873 at the very earliest, and whatever freedom or grace the dahlias now have is traceable to a single plant that

26.—*Grand Duke Alexis.* A large dahlia of peculiar form.

bloomed for the first time that year. Instead of short, stiff, artificially formed rays, this flower had long, loose, flat rays with pointed or twisted ends and the peculiar red that is associated with cacti. This variety was named *Juarezii*, in honor of Juarez, President of Mexico, and first offered for sale in 1874 by a Dutch merchant. This was the parent of the so-called cactus dahlias, a name which seems far-fetched now-a-days. It was the color

and not the form that gave the point to the comparison in the first place, and we now have a very great variety of colors in that form—colors that do not necessarily remind one of cacti. The white variety *Mrs. A. Peart* (Fig. 24), has a form very similar to that of the brilliant red cactus dahlia pictured in 1879. The The cactus type has been kept quite pure, and of late years it has also been modified into some of the loose and flowing forms of the Japanese chrysanthemums. The cactus dahlias have also been crossed with specimens of the old ball type, and there have resulted such new forms as that of *Wm. Agnew* (Fig. 30), which may be taken as one type of a class that is sometimes called the semi-cactus. Whether the variety *Miss May Lomas* (Fig. 25), has any of the cactus blood in it (I had almost written *ichor*, for I believe it is an element of immortal youth), I cannot say. The rays are still short, and show the creases of the old strait-jacket, but on the whole, the outlines are considerably relaxed and softened. It would be puzzling to explain off-hand how such a form as that of *Grand Duke Alexis* (Fig. 26) may have arisen. This may look somewhat curious and mathematical in print, but in the living flower it has a peculiar charm and grace. I should like to see a whole set of dahlias of this form through the whole range of colors. In this case, there is no chrysanthemum that I know of quite like it. We have not attained as yet such freedom of form as is expressed in the tangled mass of golden threads known as the chrysanthemum *Mrs. W. H. Rand*, nor the serpentine grace in the long slender, writhing petals of *Medusa*.

The rays only have been developed in the case of the dahlia and the disc-flowers entirely neglected. The bewildering variety of forms in the chrysanthemums have their origin in two elements, the ray and the disc-flower. The chrysanthemum *Northern Lights* is composed entirely of very long slender tubes which are arranged in a loose, whorled fashion (see Bulletin 112, Fig. 94). It will be many years doubtless before the short, yellow disc-flowers of the single dahlia can be drawn out to so great a length. But it can be done, and there is no reason in the nature of things why we should not have a race of dahlias analogous to the anemone-flowered chrysanthemums, one of which, *Mrs. F. Gordon Dexter*, is figured on the title page of Bulletin 91. These effects

can certainly be produced, and it is probably only a question of time when we shall have all the shapes of the chrysanthemums.

*Why and how dahlias should be changed.*—Perhaps some one may ask, "Why do you wish to change the nature of the dahlia? If you are satisfied with the rose as such, and the lily, and would not try to make either like the other, why do you want to make dahlias look like chyrsanthemums?"

The big round dahlia of the old school is not nature,—it is art. Or, at best it is only one type of beauty. Dahlias are not essentially big and round. It is their nature to vary into many forms. Of the forms that nature gives us, we select the ones we like and destroy the rest. There are at least two good reasons why the chrysanthemum-like forms would be desirable in dahlias; first, because the foliage is different, and flowers are entitled to different settings of foliage, just as precious stones may have their beauty set off in various ways. The foliage of the new cactus types is often distinctly graceful and beautiful. This, too, is good news for those who could not tell a field of dahlias from a field of potatoes at a moderate distance. Secondly, the growing of chrysanthemums in this climate is a highly specialized industry requiring greenhouses, capital and skill. Dahlias can be grown outdoors by everybody. Anyone can have them in his garden, and have lots of flowers, and at much less cost. It is a mistake to suppose that the best dahlias can be raised without skill and trouble. But while chrysanthemums will not tolerate ignorance or neglect, dahlias give an astonishing return for a minimum of work. Moreover the seasons are quite different. The first frost will always kill the dahlias out-of-doors while the chrysanthemums are preparing their November glories within.

These chrysanthemum-like forms are some of the best and most numerous that we have, and we cannot have too much of informal grace and beauty. We ought to have these types all the year round. The China-asters have many of these forms, as well as others not preserved among chrysanthemums and not yet achieved by dahlias, in a different set of colors, and at an intermediate season. They too have their place. These three genera, Chrysanthemum, Dahlia, Callistephus are not competitors, but friends that supplement one another, and of all the composites in

cultivation, they are by far the most promising and the most productive of new forms. They all have the same kind of materials to work with—ray and disc-flowers—and they are by nature fitted to express the same kinds of beauty. The rose and the lily have two other very different kinds of natural endowments and two very different types of beauty, not superior or antagonistic, but different.

The title-page of this bulletin illustrates a kind of beauty that is not usually associated with the dahlia. The gentleman who ordered this variety from Holland thought himself badly cheated because the flowers were small and only semi-double. It is true that semi-double forms often lack character, but sometimes they have prettiness and individuality, though they never get any prizes at the exhibitions.

*The peculiar merits of the dahlia.*—Meanwhile, what are some of the present advantages the dahlias possess? As to foliage, they have at least five times as much variety as the chrysanthemums do. They have the old familiar potato-like foliage, which is naturally rather broad and coarse. Much of this rankness, however, is due to methods of cultivation. Secondly, there is the new cactus type which is graceful and delicate enough to attract attention of itself. Between these two extremes there are many intermediate forms which the eye recognizes, but whose lines of beauty can scarcely be suggested by descriptions. Speaking only of very distinct forms, we have a very finely cut type of foliage of which *Fern-Leaved Beauty* is perhaps the best at present. Then there is still another type of foliage whose form is not so noticeable as its rich, dark red color. *Ami Barillet* has these dark reddish leaves with a single flower of cardinal. We had only one other variety of this type last year. Its single yellow flowers did not seem to go so well with this reddish foliage and perhaps some other colors may prove to be quite inharmonious with it. Here is a hint for one line of evolution for the dahlia. This reddish color is very uniform, and I am entirely convinced that it has a natural look and is not merely a curiosity. To me it looks much more at home in the garden than the purple beeches do on the streets. Finally, there is a tendency towards variegation in the dahlia leaf which seems to me fully as legitimate as the

whitened leaf-edges of many ornamental shrubs. It has appeared more than once in the history of the dahlia, and seems to be unstable and difficult to preserve. It is worth trying to keep, for at the least, it is attractive, and very agreeable for a change. The foliage of dahlias is undeniably monotonous, and a garden needs these lively touches now and then, not only to set off the genuine beauty of the more delicate forms, but also to lighten the general effect of the whole mass.

Coming now to the flowers, the old ball type is a capital form in itself, just the thing to display strong single colors, dazzling scarlet, vivid reds, big soft snowballs of white—a cool and pleasant handful—masterful yellows, rich golden yellow and truly regal purples. The form itself I have no quarrel with except that the rays are often too short and stiff and artificially folded. But I do protest against having only one ideal of beauty, just as we are advised to beware of the man of one book. A bed of old fashioned dahlias insolently interrupting the quiet restfulness of a green-sward with its loud, clashing colors, ought to be an audible protest against the man with one idea of beauty. Mere size alone in flowers is always vulgar. It is no wonder that the big dahlias are never seen in the windows of the New York florists. At the corner flower stands these huge things begin the day as big and hard as mallets. By night they have subsided into a soggy mournfulness. Women could no more wear them than a purple cabbage.

The show varieties indeed are chiefly designed for the exhibition-hall where great size is particularly admired; this is especially true of Europe, where dahlia-shows are still in high favor. It is impossible not to like some of these, but the garden is the place where they can be enjoyed most. They are a glorious sight in the sunlight, but they are inclined to look artificial indoors, and their colors are often changed or extinguished when brought into the house.

The pompons, however, are suitable for cut flowers, and their artificiality is attractive, quaint, or comical. They are like richly dressed children; their faces are very clean, and bright, and their tailor-made clothes are prim and neat or quaint and odd. Their formality is often pretty and amusing, as of those that imitate their elders. *Little Arthur*, *Little Bessie*, *Little Bobby*, *Little Charlie*,

*Little Rifleman*, *Little Valentine* and *Little Wag* are names of some pompons and there are many testimonies to their child-like grace and beauty. These pompons have been brought to a high degree of perfection. Their evolution is practically complete. They have a beauty and a place of their own, and no one would wish them any different. As a class, they offer the cheapest method I know of for producing great quantities of flowers two inches in diameter. A variety that does not have from ten to sixty flowers at a time from the 4th of July until the September or October frost is not worth keeping. They are the very thing for small yards and for certain city conditions, especially where people are likely to steal flowers. Anyone who enjoys giving away flowers should have some pompons. They grow up quickly and hide bare, ugly places and are the ideal for those people who delight in having things trim, neat and tidy. The peculiar merits of the pompon dahlias, then, are their profusion, their wide range of color, and their cheapness.

27.—*A single dahlia*

The single dahlias (Fig. 27) will probably be enjoyed as long as the star-like beauty of the daisies and marguerites is appreciated. They, too, are quite perfect in their way, and they are largely for quantity. Of late years the plants have been made dwarf and compact. There is now a whole race called "Tom Thumb Single Dahlias." I hate to talk about "improving"

flowers. It has a bad sound. To many people it is well-nigh sacrilegious to talk of "improving nature." Strictly speaking, we cannot create; we can only select from the forms that nature gives us, and keep what we like. Whoever declares that wild flowers are intrinsically more beautiful than cultivated ones, and insists on having dahlias just as they are in nature, must move

28.—*Viridiflora.* The green dahlia.

to Mexico, and will then find that the forms are not stereotyped. Nature can print "dahlia" in as many kinds of type as our best publishing houses can. Dahlias grow wild in Mexico in sandy places, at five or seven thousand feet above the sea level, know nothing of frost, and are used to a long dry season. They do vary wonderfully in Mexico and they are bound to vary even more so in New York. The dwarfing of dahlias is a perfectly legitimate hing. Nature does it, and we have a perfect right to prefer some

of her forms to others. I hate to see dahlias tied to stakes. The compact bushy plants that never grow more than two feet high have their flowers massed and make a single picture. The tall, ungainly, sprawling varieties have too much foliage in proportion to the number of flowers. There is no unity of effect. The flowers are scattered, and the attention is distracted. And the stakes are unsightly and troublesome. These dwarf dahlias, therefore, are just the thing for flower-beds and borders and wherever masses of color are wanted in small compass. The taller single varieties have been extravagantly overvalued in their day. They have even excelled the show varieties in popular favor for a time. Vilmorin still catalogues one hundred and eleven single varieties.

The peculiar merits of the cactus dahlias have been mentioned. Figures 26 and 30 are only two of many forms quite peculiar to the dahlia. The dahlia is not without its curiosities, such as sporting varieties, like *Beauty Inconstant* which bears pure white or pure yellow flowers, or pinkish ones, or red ones "freaked" with any of these colors, and *Viridiflora* the so-called "green dahlia" (Fig. 28), which is a monstrosity similar to the green rose. The range of color is even greater than that of the Japanese chrysanthemums, being particularly rich in dark reds and strong, clear shades of purple. The dahlia *A. D. Livoni* exactly matches the pink of Mr. Mathews's color chart and I am very sure that the chrysanthemums do not have it at all. Whether they can ever reach it through the color that Mr. Mathews calls crimson-pink is doubtful. Dahlias are also very rich in iridescent effects, *Ruby Queen*, *Oban*, and *Mrs. W. H. Maule* being good examples. The texture of flowers is a point wasted on people who do not love a garden. Dahlias are sometimes waxy, sometimes loose and fluffy, and a loving gardener loves to feel and handle them.

*The place for dahlias is the garden.*—They never can have a place in landscape gardening because the first frost kills them. I often think their strength is dissipated when they are strung along a walk or other border. Personally, I believe in flower beds, but not in the middle of a beautiful green lawn. The grass has a quiet story to tell, and if dahlias intrude they should be put out for disturbing the peace. I wish I could have a whole bulle-

tin in which to tell the fun of gardening. It cannot be enjoyed by proxy. I enjoy especially those gardens that have one theme, one central feature, no matter what are the modifications. A collection of roses, of sweet peas, of China asters, or of anything, has a certain unity, which, however, need not exclude minor features and miscellaneous favorites. Dahlias are the hobby of the Rev. C. W. Bolton, of Pelham, near New York City. His house is a picture by itself and one would never suspect what treasures are in his back-yard. Mr. Bolton is an early riser, and takes rest and solid comfort in his garden. He has the pompons nearest to his house, for they are the boys and girls and he catches them playing games. There are cool grass walks between the double rows of big dahlias. Mr. Bolton is rich in dahlias and he has been their friend in need. Many a beautiful dahlia has he saved from oblivion. He loves color, and this is a beautiful and easy way to get it. It is a cheap way of painting. No one can expect to raise such beautiful, large-flowering dahlias, unless he takes trouble, and no one is entitled to success who does not like to nurse plants and watch the flowers daily. Mr. Bolton's garden has been a good and cheap doctor. The pompons snuggle up against the gray walls of the church and make a warm and cheery picture.

29.—*Rev. C. W. Bolton, who connects the old-time dahlia furore with the returning passion.*

Dahlias should be in a place by themselves. Possibly a dahlia can be used now and then "as an exclamation point," a flash of color to lighten up other foliage near a house or wherever a cheerful look is desired. The herbaceous border is no place for dahlias. Indeed the big ball type of flowers is rarely furnished

by the composites amongst perennial herbs. Blue-bells and columbines are typical inhabitants of the herbaceous border and their beauty is of a different sort from the big solid ball-like dahlias.

*Dahlias as cut flowers.*—While sweet peas can be picked indiscriminately and put in a single vase, dahlias have such a wide range of color that the flowers must be carefully sorted. This adds to the fun of arranging, and gives time to look at each one separately. A vase full of a single variety gives a strong and pure effect. It is a great mistake to jumble all sorts and colors of flowers into the same jar. The European and American ideas on this subject are entirely opposed. The German idea of a bouquet is too often a cluttered lot of miscellaneous flowers all huddled together without regard to conflicting colors and different types of beauty. Dahlias go well with nothing else. They keep fairly well for about three days, and take up great quantities of water through their succulent stems. Dahlia-shows can never be as popular in America as they are in Europe, until there is a greater variety in their forms. While the garden is the true exhibition place for dahlias, where one may revel and riot in their color, the dahlia-show is not to be discouraged. The large-flowering dahlias are just as worthy of separate notice as so many paintings. They are, in a sense, works of art and deserve to be studied individually. It is, therefore, a mistake to crowd them together in a bad light. Gas light particularly, deadens and falsifies the colors of flowers.

*A few words on color.*—I made the experiment of describing all the varieties this year by the aid of color charts. Kohn's color chart was given a fair trial but proved unsatisfactory. The color chart of F. Schuyler Mathews was very handy and helpful, although Mr. Mathews employs names which may be used by artists but will never be used by the flower trade. There were two fine single varieties which were among the very first to bloom and had flowers every day until the end of the season. One of these matched the scarlet of Mr. Mathews's chart perfectly, and the other was as near cardinal as petal and pigment can ever be. These two varieties then became the standard for all near shades of red. The same variety is often described in one catalogue as scarlet and in another as crimson ; yet Mr. Mathews says there are fifty easily recognizable shades between them. The standards

for color must be within the dahlia itself, but the standards must first be chosen by some outside aid. If the American Dahlia Society would register all dahlias, and give each one an official description, using a cheap and sensible color-chart as a guide, people could have some idea of what they are buying. *Penelope* is described by Dreer as white, tipped with purple ; by Pierson as white, delicately tinted magenta ; by Rawson as pure white with violet tips, and by Peacock as pure white, delicately flaked with lavender. This illustrates the difficulty of determining a secondary color of which a small amount is present. By crowding together the petals with the hand the secondary color comes out more strongly. *Miss May Lomas* and *La France* (Maule's) belong to this same class. Their beauty lies in these delicate secondary tints which are all of purple origin and can never be fixed. Dilute purple sufficiently and you get what Mr. Mathews calls crimson-pink. This crimson-pink has two bad faults : it is inclined to be laid on unevenly in patches and veins instead of being evenly suffused, and it is so variable in quantity and quality as to make it a lottery what sort of a flower one is to get. There is only one pink dahlia I know of (for *A. D. Livoni* and *Ethel Vick* seem to be identical) that shows no trace of a purple or crimson origin. I shall not have a particle of faith in the stability of any other dahlia advertised as pink until I see it. *Mrs. Gladstone* is a very much praised variety and at Ithaca in 1896 it had a very beautiful and uniformly suffused light pink. I expected to recommend it as among the very best, and should surely have done so if I had not seen flowers from two other localities which betrayed the origin of this pink. They showed two different degrees of a hateful purple and I should never have supposed them to be the same thing. Whenever the words "lavender" "rosy-pink" or "violet" appear in descriptions of dahlias one may feel almost certain that they refer to this treacherous crimson-pink. Sometimes these tints are pretty well fixed, *e.g.* the lavender in *Arabella*.

The variety commonly known as *Mme. Moreau* would pass for for a pink until brought side by side with *A. D. Livoni*, when the purplish cast of the former is evident. In "selfs" *i.e.* flowers having but a single color, these shades are practically fixed and uniform, but variegated dahlias containing degrees of purple,

crimson, rose, magenta, violet, lavender and pink can never be relied upon from descriptions. They may be any one of these shades for they depend upon factors in cultivation which are little understood and perhaps uncontrollable. Pure and delicate shades of pink can never be reached by such means. Plant-food may deepen them all the way to purple in a single season and they are almost sure to revert to purple ancestors sooner or later.

*Variegated flowers as a class.*—Mixed color-effects can rarely compete for strength and brilliancy with singly colored flowers, and they are very unstable. "Selfs" have a unity of effect; their color is single, strong, undivided. Variegated flowers are distracting, and artificial, and remind one of the constant straining after effect. *W. C. Denzel* is one of the very few dahlias in which two colors are combined to give a soft and delicate single effect. If there is such a thing as a modest dahlia, this is surely one. It is distressing not to be able to recommend such a variety on a year's trial. Next year these same tints may deepen into a purple and a yellow that will conflict with each other. We have altogether too many variegated dahlias and not enough variety in form. They are essentially the most unstable, and the first to suffer from a popular reaction. These fanciful creations can never be permanently popular. The number of people who delight in formal flowers is certainly much greater proportionately in Europe than in America, and this leads me to make a plea for an American evolution of the dahlia. The forcing-house carnation is an American product. Carnations are grown mostly outdoors in Europe in beds and borders. They have short stems and a sudden rush of bloom in summer, and then all is over until another year. They are painted and penciled and marked in all sorts of ways foreign to our taste. Picotees can never have the permanent prosperity in America that they do in England; Americans want long-stemmed carnations the year round. We should never have had midwinter carnations at twenty-five cents a dozen if we had stuck to the old European lines of evolution.

*The need of live colors.*—It often happens that dahlias which are full of glowing color in the sunlight are very tame and subdued in the shade. Mr. Peacock the dahlia specialist of Atco, N. J.,

has done some inteiligent crossing to produce live colors. The story of the variety *Wm. Agnew* (Fig. 30) is an interesting one. Mr. Peacock noticed that most of the reds he knew had no life out of the sunlight. He began with a large ball-shaped dahlia named *Crimson Giant* the great size of whose flowers he coveted. The

30.—*Wm. Agnew*. A fine scarlet orange semi-cactus variety.

pollen of this variety was used on *Professor Baldwin*, which is said to have been a sport from the original cactus dahlia. It had a scarlet orange flower, and Mr. Peacock had noticed that a touch of orange lightens up flowers wonderfully in the shade. This was a violent cross as the parents were as far apart in form as are figures 24 and 25. In the seedling the flower had the cactus-like

form of the female parent and the color of the male parent was modified to a deep scarlet. However, the flower faded badly. This seedling was now crossed with *Cochineal*, a ball-shaped flower of rich unfading dark red. *Cochineal's* only defect was an open center of yellow, and the flowers were only medium-sized. The rich dark red of *Cochineal* did not prevail in the cross, but the fading habit was eliminated in the product which is called *Wm. Agnew* (Fig. 30). The flowers are uniformly very large, of semi-cactus type, and of a fine intense scarlet orange color. The trace of orange thus subtly infused into the flower makes it a lively color in sun or shade. This variety was no earlier than the cactus sorts at Ithaca last year, but Mr. Peacock says it is a month earlier than the rest. This unexpected trait he cannot account for, but it is one of the greatest importance as the cactus sorts are often a month behind the old school dahlias in their blooming time.

*Suggestions for plant-breeders.*—1. The lengthening of the season of the dahlia is one of the most striking examples of its plasticity in cultivation. When dahlias were first introduced they bloomed for barely a week or two before frost. Now, they ought to be in bloom by the fourth of July and some of them at least can be made to blossom continously from June 15th. The cactus varieties were on the average a month later than the rest at Ithaca, in 1896, and their season needs lengthening.

2. The ugly stakes must go. Already we have a race of single and pompon varieties that need no stakes to support them. Four feet is high enough for any dahlia plant. The cactus varieties particularly are inclined to be too tall and straggling.

3. While dwarfing in general is desirable, there is one kind of it that seems to me mistaken. *Triomphe de Solferino* is typical of a class used for bedding. It has huge flowers, coarse and flattish, and out of all proportion to the amount of foliage. I enjoy looking at cabbages,—in a cabbage plantation. I see no beauty in abnormally large flowers on abnormally dwarf plants. Here again nature gives the hint. The tendency to pompons means that a large number of small flowers is more in harmony with a compact plant than a few very large ones. I believe that extreme dwarfing of show varieties is mistaken craft and false art. The

variety named after Rev. C. W. Bolton is typical of a race of plants to be used for bedding which ought to be developed in America. *Triomphe de Solferino* has a thick stem which cuts like timber. One has to cut down nearly the whole plant and trim off the coarse, clumsy foliage in order to get two or three flowers, which are, after all, only vegetable curiosities and will not go into a vase. *Rev. C. W. Bolton* has a multitude of medium-sized flowers on long, slender stems just right for cutting. Three big flowers on a little plant distract the attention as would individual squashes, or pumpkins. Pompons have a unity of effect in their multitude of detail; and midget and lilliputian are prettier words than humpbacked dwarf.

31.—*Rev. C. W. Bolton.* Flower naturally four inches in diameter.

4. The cactus varieties often have a trick of hiding their flowers under the leaves. This is no great calamity in the case of old fashioned bedders like *Triomphe de Solferino*. Here *Rev. C. W. Bolton* (Fig. 31) is again the type and the ideal, its many slender stems raising the flowers above the foliage.

5. The whorled effect in *Priscilla*, *Blumenfalter* and others, must be pretty and novel to those who know only the old-time dahlias. Their so-called quilled rays are arranged in a circular or rotary fashion which gives a certain neatness and mock-military precision that is often pretty and attractive, particularly in young flowers, as in children playing soldiers.

6. In the march toward chrysanthemum-forms, the long, flat and slender rays will be of most help to get the free, loose, and fluffy types. Fimbriated forms, like *Guiding Star*, are desirable in themselves and may also aid in introducing irregularity. The rays of the old show dahlias are too short and stiff. Ragged, untidy and intermediate forms have possibilities.

7. We need more prizes for new forms and less effort to increase the range of color. Let the China-asters have the shades of blue. That is their mission. In *Gardeners' Chronicle*, 1879, John Keynes is quoted as saying: "The first good Dahlia I ever raised was Ovid, the seedling root of which I sold to Mountjoy for £50. I think we have never seen a nearer approach to a blue Dahlia." I have seen colored plates of varieties supposed to be on the way to blue. They were mostly shades of purple. I do not believe that an azure blue can ever be attained through either purple or lavender. Beware of crimson-pink.

8. We have as yet no forms like the tubular or Japanese anemone-flowered chrysanthemums nor many of the forms of China-asters illustrated in Bulletin 90. Apparently no attempt has been made to lengthen out the disc-florets into long, slender tubes.

9. *Princess Harry* and others may have the possibilities of a race similarly to the hairy chrysanthemums. The tendency towards hairiness appeared in England and was patiently suppressed before 1888 when the chrysanthemum craze was started in America by the purchase of the hairy variety *Mrs. Alpheus Hardy* for $1500.

10. In addition to the five types of foliage already described (p. 109), there is sometimes a peculiar glossiness on the leaves which may perhaps be turned to account.

11. Dahlias are sometimes slightly fragrant, and at least one skillful plant-breeder is now at work along this line. Perhaps a few curiosities of this sort may be obtained, but the lack of fragrance is probably a natural limitation. Dahlias have glories enough without fragrance.

12. The buds often open with difficulty and make lop-sided flowers. Chrysanthemums sometimes have this difficulty and the same misfortune has been known to occur in other com-

posites growing wild. The dahlia, howevei, is notorious for producing many imperfectly blown flowers. Some think it is one of the limitations of the dahlia and must be endured. Others think that it has not been in cultivation long enough. Some varieties are nearly free from this trouble, but I do not know whether it is a matter of variety or cultivation.

*The cultivation for dahlias.*—In sandy soils dahlias make comparatively few tuberous roots, tend to become dwarf, and flower profusely. In very rich loamy soils they make more roots and fewer flowers. Too much nitrogenous food makes a rank, coarse growth and few flowers. No amount of added plant-food can ever atone for neglect of the physical condition of the soil. Mr. Peacock is able to have fifteen acres of dahlias in continuous bloom throughout a long summer of drought. Imagine this brilliant spectacle after nine weeks without a rain ! And yet, dahlias are very sensitive to lack of moisture. While it is true that Mr. Peacock is an expert cultivator and devotes all his time to dahlias, yet like all skillful managers of the highest type, he has no professional secrets. The whole story is one of conservation of moisture already in the soil. Moisture is constantly rising by capillary action and its evaporation must be prevented. Frequent shallow cultivations break off the capillary tubes and prevent this escape of moisture into the air. This earth-mulch is obtained in the garden by lightly stirring the two or three inches of surface soil with a hoe or rake. Below that depth the soil should be constantly moist, not wet, throughout the whole growing season.

The large-flowering varieties need a space of four feet square to bring them to perfection as individual plants. The best results are gotten from planting them in rows so that they may be thoroughly cultivated. These rows should be at least five feet wide if a horse is to be driven through frequently.

There are three systems of training dahlias, that deserve notice. First, a policy of non-interference which allows as many shoots to come up from the roots as may. This is the proper way to grow most of the varieties catalogued as pompons, dwarfs, and bedders. In the large-flowering and cactus kinds, where fewer and more perfect flowers are desired, this method will not do, because the shoots compete with each other and exhaust the

vitality of the plant in producing foliage instead of flowers. The second method might be called the main trunk system. Only one shoot is allowed to grow from a clump of roots, all the other shoots being pinched off. This method, therefore, produces a tree-like growth, instead of a bushy form like the first. However, this system, which is the old-fashioned one, requires stakes and tying, for such plants will droop and split and are badly broken by high winds.

The third method is the "single stem branching system" which is successfully practiced by Mr. Lawrence K. Peacock and described in his book, "The Dahlia," at page 24. It is a most ingenious device for doing away with the unsightly stakes, and has many incidental advantages. All the shoots but one are removed, and this one is allowed to grow until two pairs of leaves are above ground with a young and unexpanded growth on the top. This undeveloped portion is pinched off, and four young buds which are lurking in the axils of the two pairs of opposite leaves are very much rejoiced. Some or all of them will now grow out into long branches. Let us suppose that all four of them grow equally. The plant will then have a very short, thick and strong single stem which comes up only an inch or two above ground and then gives place to four long branches. These branches are strong enough to hold themselves up without stakes and they can endure heavy winds. Indeed, a still greater division of labor is desirable, and each of these growing branches should have its terminal growth pinched out at the same early stage already indicated, *viz.*, when only two pairs of leaves are fully developed. Practically, however, plants do not grow in this mathematical way, for one of the two buds waiting for a chance, usually gets the start of his fellow and soon outclasses him. The practical thing to do is to keep the plants from making a main trunk. The object is to have the plants branch at the surface of the ground, and the pinching must be done as early in the season as possible. It is a common belief among gardeners that late pinching makes short-stemmed flowers, and early pinching gives the long stems so much desired. This system therefore, means work and watchfulness, but it causes less trouble than staking and tying.

It is best not to take up the dahlia roots for at least a week

after frost, as the tubers ripen better and are not so likely to shrivel when stored in the cellar over winter. The roots should be turned upside down in the sunshine to let the water drain out of the stems.

Cut flowers of dahlias can be shipped for at least three hundred miles if they are carefully packed in boxes six inches deep. They are sure to spoil if more than one layer deep. Moss must be used about the stems and the bunches should be small and securely wrapped with oil paper They demand a great deal of room for long distance shipments. For short distances, they can be more compactly and easily handled.

*A good word about frost.*—The first freeze is sure to kill the dahlias, but frosts can be prevented. A freeze is a disturbance over a large area, and is usually associated with winds. A frost is a local affair, and comes on cloudless nights when no air is stirring. Frost is due to the quick radiation from the earth after night-fall. Clouds reflect this warm radiating energy. There are two ways of preventing the heat of the earth from quickly radiating off into space,—making an artificial cloud, and making the atmosphere moister than the soil. A few degrees of frost can be averted by simply sprinkling the plants thoroughly at night-fall. On large plantations it will pay to have a man stay up all night and keep a dense cloud of smoke constantly hanging over the field. This method is used among the vineyardists in parts of France. Neighbors are warned to expect frost by a system of alarm-bells. Foyers, or boxes of tar compounds, are lighted and make a dense smudge. The smell is enough to keep the attendants awake. Any damp rubbish that will burn with a great smoke will do. Some weeks after all the dahlias near Philadelphia were killed by the first frost an enterprising dealer was shipping from eight to ten thousand cut flowers of dahlias to the city every day. He had saved his plants by one night's work. It often happens that there is a light frost in early September and not another sign of frost for three or four weeks after.

*The commercial possibilities* are very great. It is the next flower to be urged upon the notice of the American public. The machinery of the floral trade is working for it. Quantities of dahlias have been given away by dry-goods stores, and

people are surprised that these new and graceful forms are those of dahlias. We cannot have too many flowers. It is pleasant to have lots to cut and lots to give away. The cactus dahlias are evidently to be the next great commercial success in the floral world. Popular enthusiasm may come and go, but their freedom and grace of form, and brilliant colors entitle them to permanent prosperity.

*Origin of the cactus dahlia.*—The following is the first description of the cactus dahlia, published in England. It is from the *Gardeners' Chronicle* for Oct. 4, 1879.

"At one of the recent meetings of the Royal Horticultural Society considerable attention was attracted to a remarkable Dahlia, exhibited by Mr. CANNELL under the name of the CACTUS DAHLIA. In the Dahlia as ordinarily seen the florets are rolled up so as to resemble so many short quills open at the ends, but in the present case the florets were all flat or nearly so, strap-shaped like the outer florets of the original species (ray-florets), and of a rich crimson colour. The appearance was, therefore, very striking, and suggestive of a new race in Dahlias analagous in some respects to the Japanese Chrysanthemums."

The following is from the *Gardeners' Chronicle* for Nov. 8, 1879:

"DAHLIA JUAREZII.—When a short time since we figured this remarkable Dahlia from specimens sent us by Mr. CANNELL, we took some pains to ascertain its history, but with little result. Thanks to Mr. Krelage, of Haarlam, and Mr. Jongkindt Coninck, of the Tottenham Nurseries, Dedemsvaart, near Zwolle, we are now enabled to give the history of this Dahlia, as narrated by the introducer, in the Dutch journal *Sempervirens*.

"'When reading the *Gardeners' Chronicle* of October 4, 1879, I was agreeably surprised to see a well-made figure of natural size of an old acquaintance of mine, Dahlia Juarezii. I was still more surprised to see by the few additional lines that very little is known about the origin of this beautiful Dahlia, be it a species or variety. I am, therefore, pleased to avail myself of the opportunity of giving a few details about its origin and history, and to say that I imported it directly from Mexico, and was the first who introduced it to the trade in the Netherlands as well as in other countries. In the autumn of 1872 a friend of mine in

32.—*Matchless.* A velvety maroon cactus dahlia. Half size.

Mexico sent me a small case containing different kinds of seeds, bulbs, and flower-roots from that country. The case was a long time on the road, and, as often happens with private importations, the plants arrived in a very poor condition ; the seeds were mixed, partially germinated, and spoiled ; the bulbs and flower-roots rotten. However, I kept all that was in a tolerable condition, carefully awaiting the result. At last, from a very small flower-root, a tender shoot developed itself, which soon proved to be a Dahlia. It being winter I could only make cuttings of it. Having taken great care of them, I was much pleased to obtain in the spring of 1873 a few young plants of this Dahlia. When planted out in June in the open ground with my other Dahlias, it flowered at the same time as these, and not only surprised me, but all who saw it in bloom, by its large rich crimson flowers, quite different from all other Dahlias. The brilliant red colour of its flowers nearly equaled that of the poppy, and was very showy even at a good distance. My catalogue of 1874, in which year I first introduced that Dahlia to the trade, will prove the truth of my assertions. In that catalogue it is mentioned for the first time under the name of Dahlia Juarezii, which name I gave it in honour of Mr. JUAREZ, then President of Mexico. The fact of Messrs. ANT. ROOZEN & SONS, at Overveen, deriving it from France, is easily understood, when I say that I yearly send to one of the leading French seedsmen a great many Dahlia roots, amongst which were some of Dahlia Juarezii. It is remarkable that the name of Cactus Dahlia should be used in the *Gardeners' Chronicle*, as in my catalogue of 1874, in which I first mentioned it, I said that its flowers when seen at some distance resembled those of Cereus (Cactus) speciosissimus. To maintain the honour of Dutch horticulture, I deem it desirable to write these few lines.—*J. T. Van der Berg*, *Juxphaas, near Utrecht.*' "

*Books, societies and dealers.*—There are four books devoted entirely to the dahlia, of which only one is modern. "The Dahlia," by Lawrence K. Peacock, is an illustrated book of fifty-six pages. The books of E. Sayers, Boston, 1839 ; Joseph Paxton, London, 1838, and of Robert Hogg, London, 1853, are out of print and out of date.

The secretary of the American Dahlia Society is Lawrence K.

Peacock, Atco, N. J. The Secretary of the National Dahlia Society of England is T. W. Girdlestone, Sunningdale, Berks.

In order to answer the inquiries of our readers in advance, we give a list of American dealers who catalogue more than twenty-five kinds of dahlias, whose lists have come to our table:

A. Blanc & Co., 314 N. Eleventh St., Philadelphia, Pa.

Henry A. Dreer, 714 Chestnut St., Philadelphia, Pa.

John Gardiner & Co., 631 Market St., Philadelphia, Pa.

Peter Henderson & Co., 35 Cortland St., New York, N. Y.

Wm. Henry Maule, 1711 Filbert St., Philadelphia, Pa.

Samuel C. Moon, Morrisville, Pa.

Wm. H. Moon, Morrisville, Pa.

W. P. Peacock, Dahlia Specialist, Atco, N. J.

F. R. Pierson Co., Tarrytown-on-Hudson, N. Y.

Pitcher & Manda, Short Hills, N. J.

W. W. Rawson & Co., 34 South Market St., Boston, Mass.

John Saul, Washington, D. C.

The Storrs & Harrison Co., Painesville, O.

Vaughan's Seed Store, 84 Randolph St., Chicago, Ills., and 26 Barclay St., New York, N. Y.

James Vick's Sons, Rochester, N. Y.

W. W. Wilmore, Dahlia Specialist, Denver, Col.

The following is a partial list of foreign dealers who catalogue a great many varieties of dahlias:

England.

H. Cannell & Sons, Swanley, Kent.

J. Cheal & Sons, Crawley, Sussex.

Charles Turner, Slough.

Thos. S. Ware, Tottenham, London

Germany.

(Dahlias are commonly called *Georginen* in Germany.)

Max Deegan, Köstritz, Reuss-Thüringen.

Haage & Schmidt, Erfurt.

Carl Kaiser, Nordhausen.

France.

L'Établissement Horticole Bruant à Poitiers (Vienne).

Vilmorin-Andrieux et Cie, 4, Quai de la Mégésserie, Paris.

New Zealand.

D. Hay & Son, Auckland.

*The Cornell variety test of 1896.*—Three hundred and fifty-four different named varieties were grown at Ithaca last year. There were over a thousand varieties catalogued in 1896 in different parts of the world. Our card-index has over two thousand names already, and no effort has been made to trace the older varieties back to their original descriptions. The Cornell University Library has all of the important horticultural journals and magazines complete, except the earlier volumes of *Gartenflora*. The *Gardeners' Chronicle* has accounts of dahlia shows and descriptions of varieties from 1841 down to the present time. We should be very glad to receive any old books or catalogues containing descriptions of dahlias. We also desire varieties which are not on our list of varieties tried in 1896. The reader may be interested to know that we shall have growing next summer a good collection of the wild dahlias of Mexico.

Like all garden plants that have been idolized and neglected, the dahlia suffers greatly from having its names of varieties badly mixed. At least thirty-one of the varieties sent us have names that may mean two or more things each. It is also very common to find the same thing under different names. It is enough for present purposes to determine that *A. D. Livoni* and *Ethel Vick* are evidently two names for the same thing, without attempting to trace back the variety to its original description. The determination of synonyms is a work that takes years and implies a large collection of books, considerable expense, and the co-operation of the trade. *Arabella* and *Mrs. Peary* are two varieties that are said to have originated independently, but they are so nearly alike that both would never be desirable in small collections. They are typical of a class that are practically synonymous, but where there is a chance for individual judgment and preference.

The public should be cautioned not to expect the highest results the same year roots or plants are received. The quickest

way to get best results the same season is to order large clumps of roots from trustworthy firms that give prominence to the dahlia in their catalogues. Our dahlias were frequently cultivated and hoed in 1896, but were given no commercial fertilizers, the object being to judge them under ordinary conditions. This year they may be given extraordinary care and judged at their best. Many of the varieties produced no blooms at all in 1896. A. Blanc & Co. sent 79 varieties, containing mostly importations and very recent varieties which were received too late to be fairly compared with the rest. W. W. Wilmore, the dahlia specialist of Denver, Col., sent a large collection which suffered unjustly because it was detained indoors until some tardy shipments arrived which had been promised by a certain date. Henry A. Dreer sent 136 varieties, W. P. Peacock 58, and James Vick's Sons 8 varieties.

Of all these varieties there were about sixty that behaved well the first year and which seemed to be quite perfect in their way. I had hoped to say a good word for all of these, but the list has been sadly cut down in several ways. In the first place, there were many names which may mean two or more things. *Dandy* is the name of an English and an American large-flowering variety and also of a pompon. Cannell gives two varieties named *Hector*, one directly following the other. Secondly, we received the same thing under different names. *Maud*, *Marguerite* and *Model of Perfection* produced the same kind of a magenta flower, altogether the best of that color in the large-flowering class. Thirdly, I do not feel safe in recommending any variety with crimson-pink in it, not even the variety commonly known as *Mme. Moreau*. This is a very serious matter and has come up in the chrysanthemum test in a curious form. Some of the very best and purest white flowers we had were described as pink in the catalogues. Fourthly, at least five of the very best sorts which were used as color standards turned out to be not true to name. I should be glad to recommend these varieties if I could be sure of the names. Fifthly, there are certain parts of the color range that seem to be very much over-crowded. Dahlias are singularly rich in purples and dark reds. The competition is so great that there are often a dozen or more kinds with differences minute enough to show different origins but too nearly alike in

general effect to allow all to survive. Some of these are sure to go sooner or later, and the sooner the better. In such cases it is often simply a question of individual preference. In the case of some fifteen pompons where judgment has been suspended, the problem has resolved itself into a mere matter of relative profuseness. The prolific habit is sometimes fixed in the variety, and sometimes varies from year to year according to cultural conditions. This important character cannot be determined in a single year.

Some of the best known varieties are sadly missing from the recommended list, simply because of their behavior in this one locality. It is very trying to keep silent about *Red and Black*, a beautiful banded cactus variety because it was not prolific enough at one place, one year. We must have a high standard, particularly of profuseness. It is also hard to deny myself the pleasure of putting *Clifford W. Bruton* and *Mrs. W. H. Maule* in the recommended list, on the strengh of seeing them elsewhere. These varieties were not sent to us. The former is by all odds the purest yellow of any large cactus I know of. The latter has a red flower with a wonderful bluish cast, giving an iridescent effect. Then again, there are many good varieties which are not recommended simply because there are better ones in sight or to be hoped for. *Sternfalter* and *Glare of the Garden* are examples.

I do not believe the general public needs more than three hundred of the two thousand or more varieties now offered by name, but I suppose that there are at least three hundred varieties so pronounced and individual that no one could wish them any different. Let us suppose that there are seven factors that make a variety desirable :

Height—say five degrees, between very dwarf and very tall.
Foliage—at least five types.
Form of flower—say three types, that of D. variabilis, D. Juarezii, and of forms intermediate between these two species.
Doubleness of flower—say only two degrees.
Size of flowers—say only two degrees, large and small.
Color of flowers—say thirty easily recognized colors.
Variegation—say ten styles of marking.

The man with one standard of beauty ought to blush for shame at the suggestion of the combinations made possible by the mul-

tiplication of these factors. But I fear that he has no imagination and cannot see how there may be three hundred or more types of beauty, each of which is true to an ideal and leaves nothing left to wish for. Take it or not, but do not say one is better than another. It is all a matter of individual preference. For these reasons the inevitable question, "What are your twelve best varieties?" is something of a temper-tester. But it is a perfectly fair question if it implies individual preference and disregard of curiosities and varieties for special purposes. It is a very practical one, and here is the answer that I give based on one year's behavior of the plants:

*Mrs. A. Peart*, cactus, white.
*Nymphaea*, cactus, pink.
*Wm. Agnew*, cactus, scarlet orange.
*Maid of Kent*, cactus, scarlet and white.
*Black Prince*, cactus, dark red.
*Grand Duke Alexis*, large flowered, chiefly white.
*A. D. Livoni* or *Ethel Vick*, large flowered, pink.
*Rev. C. W. Bolton*, large flowered, variegated, red and yellow.
*Fern Leaved Beauty*, large flowered, banded, red and white.
*Guiding Star*, pompon, white, imbricated.
*Vivid*, pompon, scarlet orange.
*Ami Barillet*, single, scarlet.

The following varieties are recommended on the basis of a year's behavior at Cornell:

### SECTION I. SINGLE VARIETIES.

A. Foliage reddish.

*Barillet, Ami.* Dark scarlet; not up to the standard of profuseness. Curious, and interesting to amateurs and plant-breeders.

AA. Foliage green.

Scarlet.

*Downie, John.* Very early, and very productive; stems suitable for cutting.

Scarlet orange.

*Fife, Duchess of.* Quite productive especially in latter part of season; suitable for cutting.

Cardinal.

*Cowan, John.* Very early and very productive; stems suitable for cutting.

Crimson.

*Gartenfalter.* Dark crimson; a strong color, and quite pure at close of

the season; not everyone likes this color; too late to be an ideal variety, although it was productive enough late in the season.

SECTION II. POMPON VARIETIES.

A. Type not fixed; quality, quantity and position of colors variable.

*Beauty Inconstant.* White, yellow and various shades of red or pink; two or more colors may be combined in the same flower; very attractive; was not as prolific last year as Pompons should be and commonly are.

AA. Type well fixed.

B. Rays cut, or imbricated.

White.

*Guiding Star.* The nearest to pure white in this class that I know of. There is a little yellow at the base of each ray which ought to be eliminated to make the variety entirely perfect.

BB. Rays not cut, or imbricated.

C. Colors single.

Orange.

*Kleine Domitea.* Early, prolific.

Scarlet Orange.

*Vivid.* Perhaps the most intense and brilliant color of all tried last year; not as productive as the average pompon in 1896. Possibly the color is nearer to pure scarlet than scarlet orange.

CC. Colors, two or more.

Whitish, shading to crimson.

*Little Najade.* Recommended chiefly because very early and very prolific. In small collections the choice would be merely one of preference of color between this and *Eleganta.*

Pinkish.

*Eleganta.* Face shades of jacqueminot (Kohn), reverse pink (Mathews). The nearest approach to a pure pink I know of in this class, taking *A. D. Livoni* as the standard of pure pink among dahlias.

SECTION III. LARGE-FLOWERING VARIETIES.

A. Leaflets deeply lobed.

White, margined red.

*Fern-Leaved Beauty.* Flowers too few, and small for an ideal commer cial variety. This is of the greatest interest to the amateur and plant-breeder. Habit dwarf. Suitable for bedding.

AA. Leaflets of the common type *i. e.*, not deeply lobed.

B. Colors single.

White

*Purity.* The nearest to pure white in this class, that we had. There is a slight amount of yellow at the base of each ray which tones the general effect very slightly and should be eradicated from the ideal white. Early, prolific, and habit ideal. Excellent for cutting.

White, suffused blush pink.

*Ruth.* The pinkish tinge is so faint as to allow the flower to pass for a white at a little distance. In small collections it would be an equal choice with *Purity.* Must be distinguished from *Miss Ruth.*

Yellow.

*Pluton.* Very early and very prolific, far more so than any other yellow dahlia of the old school in trial of 1896. Rather formal and stiff. For some reason it was often not double enough with us to be entirely globular.

Buff.

*Crown Prince.* Flowers very large, late, and rather few. The plant was one of the very tallest. Foliage very coarse.

Pink.

*Livoni A. D.* Pure pink with no trace of a secondary color. Flowers medium sized, profuse. *Ethel Vick* seems to be exactly the same thing.

Scarlet.

*Blaine James G.* Flowers early, very large, and very profuse. Great size does not seem to bring coarseness or vulgarity.

Purple.

*Honest John.* A peculiar shade, not the ordinary purple. Early, very prolific. Habit very good. This is a very attractive variety and most people like it.

Salmon.

*Askins, Mrs.* Reverse salmon pink; flowers sometimes freaked with pinkish rays; late and rather few blooms in 1896; described by Wilmore as "deep fawn."

BB. Colors two.

C. Both colors on some of the rays.

White and lilac.

*Alexis, Grand Duke.* Late and scanty bloom in 1896; this is well worth the having for amateurs even if there should be only two or three flowers; I know of no other dahlia having this particular form; inner rays tipped lilac.

CC. Both colors on all rays.

D. Shaded; *i. e.* colors about equally divided between lower and upper half of face of each ray.

Purple and magenta.

*Ruby Queen.* Purple madder brown shading to dark purple and magenta; The coloring is very rich and bears close inspection; it was very attractive and made about an equal number of friends and foes in 1896.

DD. Variegated; i. e., streaked and dotted.

Yellow, streaked cardinal.

*Bolton, Rev. C. W.* Very early and very prolific; flowers borne well above the dwarf, compact, bushy foliage, on long slender stems suitable for cutting. Easily the best variegated dahlia of the globular type in the trial of 1896.

Straw, streaked magenta.

*Fawcett, Lucy.* Early; prolific; tall and suitable for cutting. There are really two secondary colors beside the straw-colored ground and sometimes the flowers come "solid" in either of these secondary colors; these varia-

tions have been saved and perpetuated. The variability is one of the good features of this variety for amateurs.

Maroon.

*Sladden, John.* Very dark maroon. This gave few and late blooms in 1896 at the Cornell Experiment Station. If I could have only two dark colored flowers of the globular type I should select *Honest John* as being dwarfer, earlier and more productive.

DDD. Margined.

White, margined, cherry red.

*American Flag.* Flowers never more than medium sized, and not early in 1896. Moderately productive. Type pretty well fixed; well named and always attracts attention.

SECTION IV. CACTUS VARIETIES.

A. Flower stems drooping.

Yellow.

*Lemon Giant.* Light yellow; flowers very large; flower stems very long, slender and naturally drooping.

AA. Flower stems erect.

B. Colors single.

White.

*Peart, Mrs. A.* See Fig. 24.

White.

*Patrick, Henry.* This was late and produced many imperfectly blown flowers. *Harry Freeman*, which Turner, 1896, p. 20, says is an improvement on *Henry Patrick* was a week later and otherwise much the same as regards flowering. The habit is different. No small garden needs both.

Scarlet.

*Kynerith.* Dark scarlet, edged cardinal.

Scarlet.

*Agnew, Wm.* Scarlet toned with an infusion of scarlet orange. Much earlier than its class and prolific; color very brilliant in sunshine or shade. Redder than the variety *Orange Scarlet.*

Salmon.

*Michell, Henry G.* Reddish salmon; flowers very large.

Salmon.

*Little Cactus.*. Has the dwarf habit and small flowers of a pompon but hardly sufficient profuseness. Seems to have possibilities for the plant-breeder.

Red.

*Black Prince.* The darkest red I know. Form peculiar and interesting. The rays are like the sides and bottom of a long slender box.

Magenta.

*Rosacactus.* (Deegen, 1892, p. 5, No. 4019.) Rosy magenta, a color displeasing to some. Early and very prolific. Flowers very large and very few imperfectly blown.

Maroon.

*Bragg, John.* Purple madder brown ; usually described as dark maroon, nearly black.

*Matchless.* Velvety maroon.

BB. Colors two or more.

Red and White.

*Maid of Kent.* The shade of red is between scarlet and cardinal. It shades through pink to a brilliant white. The texture and luster are very remarkable. Form about half way between the globular and cactus type.

Salmon and pink.

*Oban.* Salmon and crimson pink, iridescent, a peculiar and delicate combination of colors. Described by Peacock as rosy lavendar, overlaid delicate silvery fawn. The variety sent as *Ernst Kelway* was identical with this. *Lady Marsham* is similar but has more of the rose color.

Pink and white.

*Nymphæa.* Shell pink, inner rays at times nearly white. Sometimes slightly fragrant. These flowers in a vase are often compared to water-lilies. It is perhaps the most famous of American varieties and has had much to do with bringing about a revival of interest in dahlias.

WILHELM MILLER.

**Bulletin 129.** **February, 1897.**

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

**CHEMICAL DIVISION.**

HOW TO CONDUCT

# FIELD EXPERIMENTS WITH FERTILIZERS.

By G. C. CALDWELL.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

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The regular bulletins of the Station are sent free to all who request them.

## BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk About Dahlias.
129. How to Conduct Field Experiments With Fertilizers.

CORNELL UNIVERSITY, Ithaca, N. Y., Feb. 27, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

*Sir:*—The very commonest and most urgent question which the farmers ask of us is how to tell what fertilizer their land needs; and this is the very question which cannot be answered save by getting the answer directly from the very soil and the very crop of which the knowledge is wanted. This means that the farmer must experiment and observe. How much good he may derive from this experiment will depend upon how accurate he is, and especially upon how much he knows about soils and the requirements of plants. In all our extension teaching, we have found no specific need so great amongst the grown-up farmers as the means of answering the question of how to fertilize the land. This little paper will put the diligent farmer in the way of finding out; and it is hopefully submitted as one of the bulletins of the Experiment Station Extension, or Nixon, bill.

L. H. BAILEY.

Plan of a set of plats upon which the farmer may ask the soil and the plant what fertilizers are needed :

| | | |
|---|---|---|
| 1 | S plat. | |
| 2 | K plat. | 20 lbs. muriate of potash. |
| 3 | N plat. | 20 lbs. nitrate of soda, or 40 lbs. tankage or dried blood. |
| 4 | K N plat. | 20 lbs. muriate of potash, 20 lbs. nitrate of soda; or 20 lbs. muriate of potash, 40 lbs. tankage, etc. |
| 5 | O plat. | No fertilizer. |
| 6 | P plat. | 40 lbs. plain superphosphate with 15% phosphoric acid. |
| 7 | K P Plat. | 20 lbs. muriate of potash, 40 lbs. superphosphate. |
| 8 | N K P plat. | 20 lbs. nitrate of soda, 20 lbs. muriate of potash, 40 lbs. superphosphate ; or 40 lbs. tankage, etc., 20 lbs. muriate of potash, 40 lbs. superphosphate. |
| 9 | N P plat. | 20 lbs. nitrate of soda, 40 lbs. superphosphate; or 40 lbs. tankage, etc., 40 lbs. superphosphate. |

Size of plats 1-10 acre. Upon each plat the same crop is to be grown, care being taken that the seed is pure and that each plat receives exactly the same amount of seed.

(S, stable manure ; K, potash ; N, nitrogen ; P, phosphoric acid ; O, no fertilizer).

# HOW TO CONDUCT FIELD EXPERIMENTS WITH FERTILIZERS.

Water and its constituents hydrogen and oxygen, and carbon, nitrogen, phosphoric acid, potash and lime are the chief components of every crop that the farmer or the horticulturist produces. If the quantity that the crop can get of any one of them is too small for the making of a good yield, the yield will not be sufficient no matter how much there may be of all the others. If the quantity of any one of them is more than enough for a good yield, it is only foolishness to supply any more of that substance in fertilizers. The supply of water and its constituents, and of carbon, are practically beyond the control of the crop-grower except in so far as water may here and there be supplied by irrigation, or may everywhere be conserved by shallow surface tillage properly managed. The supply of lime is usually large enough in ordinary arable soils. Therefore only nitrogen, phosphoric acid and potash are left to be looked after ; these, as every consumer of commercial fertilizers knows, are the things that he pays for in whatever of these fertilizers he buys.

By the introduction of leguminous plants, such as clover, vetch, lupine, peas, beans and the like, into his rotations, he may save himself from the necessity of buying so much nitrogen as he might otherwise have to get in order to preserve the proper balance of the plant-foods in his soils. These crops, as almost every farmer knows, can get a part of their nitrogen from the air ; and they will in general get more of it from the air and less from the soil the poorer the soil is in available nitrogen, and the richer it is within certain limits in potash and phosphoric acid.

Every ordinary arable soil has far more than enough of nitrogen, phosphoric acid and potash for the production of a good many crops ; and yet there are many such soils which will not yield paying crops unless fertilized with one or more of these very same plant-foods.

It may be taken for granted that an acre of every such soil contains in the uppermost twelve inches at least 5,600 lbs. of nitro-

gen, 5,000 of potash and 3,800 of phosphoric acid. These quantities are from 50 to 500 times greater than those sold off the farm in any crop. There is at least 50 times as much nitrogen in such a soil as is sold in any part of any crop, and much oftener 100 or even 200 times as much. There is at least 100 times as much potash as is carried off the farm in any part of a crop sold, and oftener 500 times as much. Similar figures might be given for phosphoric acid. Why, then, must we fertilize our soils, in one way or another?

The one most important reason is that these plant-foods in the soil are for the most part in an insoluble, or as very commonly said, unavailable form, and that they usually become available only little by little each year. That they do thus become gradually available, is clearly shown by some of the experiments of Lawes and Gilbert, of England; some of their plats have yielded crops of wheat and other cereals now for fifty years and more, without any manure.

It may be, however, that one of these foods does become available year by year in large enough quantities to contribute its share towards a good yield of some crop, provided that there is enough of the other two, but that there is in fact not enough of the other two; or it may be that enough of two of the foods will become available fast enough each season for a good crop, but that the other one will not; there will be only a poor crop in either case.

There are cases in which it would be only folly, with some thousands of pounds of the one or the two foods in the soil, and in such a condition that the crop grown on it can get all it needs for a good yield, (at least for one year, and probably for the next year, and even for a few years more), to buy these foods in commercial manure; nor would it be the height of wisdom to keep putting them on the soil year after year in stable manure, since that also contains the three foods under consideration, as well as other useful substances.

There are therefore two ways of using manures of any kind, stable or commercial. One may he called the blind and unbusiness-like way, the other the sharp and business like way. We will consider only the second way.

The man who follows this second way, realizes that it may not be necessary to supply every crop on every soil with all three of the plant-foods mentioned above. He knows that different crops, while needing all these foods do not need the same quantities of all of them; he may suppose that this soil or that soil on his farm will yield an ample supply of one or two of these foods for as big a crop of some one kind as he wants to get, and he realizes that it may be profitable for him to find out what the real state of the case is.

The only way to get this information is the way by which pretty much all that we know about agriculture has been learned—by experiment. The crops that it is most profitable for him to raise must be fed, on the soil upon which he wants to raise them, with these three plant-foods, one by one, and with mixtures of them in the four combinations only that are possible. This is no easy road to learning; but for an intelligent farmer who has any disposition at all to study his business it will be pleasant work, and will put some variety into his otherwise too monotonous occupation.

I propose, then, to give full and simple directions for making these experiments in as reliable a manner as possible, and with the least possible expense and labor.

*The selection of the field.*—The field should be as uniform in character throughout as possible, and should have borne the same crop all over, at least in the preceding year, and should have been manured alike all over for that crop. If the field has been pretty well exhausted by a three or four-year rotation, more decisive results will probably be obtained than if it is in good condition. If not level or nearly so the slope should be as uniform as practicable. The underdrainage should be at least fairly efficient and uniform. The field upon which it may be most desired to make the experiment may not meet all these requirements; but it is probable that a fair approach to it can be made in most parts of this state.

*The size, shape and arrangement of the plats.*—The size should depend on the uniformity of the soil; for a very large field, and not fairly alike in the character of the soil and previous manuring

and cropping, larger plats would be advisable than for a smaller field of even character. The size of the plat must be determined also by the kind of crop that is to be experimented with. For a vineyard it should be larger than for corn; and for corn larger than for wheat or any similar sowed crop.

Long and narrow plats are generally considered as better than square ones, or broad and short ones. One advantage gained by long and narrow plats is that if there is unlikeness in strips across the field, all the plats can be laid out so as to run across those unlike strips; all the plats will then gain or lose alike.

*The best arrangement, then*, is to have plats as narrow as they can be and still carry a reasonable number of rows of the crop, and, unless the field is too large, extending from one side to the other, and across all unlike strips. Such an arrangement would reduce the labor of planting and tillage to a minimum, besides securing the probable advantage of greater evenness in results.

A set of plats seventeen and one-half feet wide would carry five rows of corn or potatoes, with three and one-half feet between the rows; there would then be three rows to harvest for the measurement of the crop, the two outside rows being rejected. For cereals, as wheat, rye, barley and oats, plats as wide as could be sown with the drill, with two or three feet vacant spaces between the plats, would answer. For small fruits, plats carrying three rows should be taken, the fruit of the inner row only being harvested for the measurement of the crop.

*The fertilizers.*—For *phosphoric acid* use what is called plain superphosphate. Dissolved bone black comes nearest to this of any fertilizer in the market. One responsible firm guarantees its dissolved bone black to contain sixteen to eighteen per cent of available phosphoric acid.

For *potash* use the high-grade muriate, which is always of good quality when obtained from reputable dealers. Only in exceptional cases would it be better to use the more expensive sulfate.

For *nitrogen*, wherever the fertilizer can be applied as a top dressing on the growing crop in early spring and again in early summer, use nitrate of soda, the cheapest nitrogen fertilizer on the market. But if for any reason it is impracticable to apply the nitrogen in this manner, use fine ground tankage or dried and

ground blood and meat; the former is a little cheaper. Either of them can be mixed with the phosphate and the potash and applied at the time when the seed is put in the ground, or earlier.

*The quantity of the fertilizer to be applied.*—A liberal dressing will be more likely to give a decisive answer to the question put by the experiment than a scanty dressing will. I would recommend the following quantities per acre: of nitrate of soda, 400 pounds, or of tankage or dried blood used instead of nitrate of soda, 600 pounds; of plain superphosphate, 800 pounds; of muriate of potash, 800 pounds. The fertilizers should be dry and finely powdered, and if applied together should be first very thoroughly mixed.

*The cultivation of all the plots* of the same set should be as nearly alike as possible. Therefore the whole of that portion of the field selected for any one set of experiments should be plowed and otherwise prepared for fertilizing and seeding on the same day; all the fertilizer that is to be applied and the seed should be put in on the same day. If nitrate is to be used as a top dressing it should be applied on all the plots of a set on the same day Each cultivating or hoeing of the plots of one set should be done. and the crop of all the plots of a set should be harvested, on the same day. As soon as practicable after every rain, every plat should be surface stirred to the depth of two or three inches, in order to conserve the moisture.

All these directions being followed, differences between the yields of different plats, due to any other causes than differences in the fertilizing, will be reduced to a minimum, and the results due to differences in fertilizing will be likely to come out more clearly.

The number of plats for one complete set of experiments and the manner of fertilizing them is shown in the diagram at the beginning of this bulletin; the size of the plat is supposed to be one-tenth of an acre. The abbreviations used are K for potash, P for phosphoric acid, N for nitrogen, O for no fertilizer, and S for stable manure, if it is desired to have a plat so fertilized in order to show whether there is profit in using any combination of commercial manures instead of the home-made product.

For the sake of economy in cost of fertilizers and labor, the

size of the plats can be reduced to one-twentieth of an acre; if the field is fairly uniform in character, the results with smaller plats might be just as reliable as those with larger plats. Of course only half as much of each fertilizer will be required on plats half as large as those indicated in the diagram.

The growing crops should be looked over from time to time, and a record should be kept of any differences observed between the different plats, of attacks of insect pests or of fungous diseases. A record of the weather should be kept.

*The harvesting of the crop.*— In carrying out this part of the work, allowance must be made for the possible growth of the roots of one row into the feeding-ground of the adjoining rows; thus the outside row of one plat may steal food from the next plat that was not intended for it; hence the directions to exclude the two outside rows of each plat, one on one side and the other on the other side, and not to include the crop of those rows in the harvest measured, are important. Since this cannot be done conveniently with wheat and other small grains, it is recommended to leave vacant spaces of two feet between the plats.

In measuring the crop, due credit should be given for every part of it that can be utilized in any way; if corn, not only the seed, but the stalks; if wheat, oats, etc., the straw as well as the seed; if potatoes, of course only the tubers.

*The results.*—In spite of all the care that may be taken in carrying out these soil tests, irregularities will appear in the results, sometimes so great that it is not easy to decide what their real meaning is; weather, soil, tillage and fertilizer work together for the making of the crop on each of the plats. All the plats suffer alike in bad weather and rejoice alike in good weather; the tillage has been the same for all the plats; all the plats were planted on the same day; only the fertilizing is different, because we made it so. The soil we suppose to be at least fairly uniform throughout; if, however, it does differ seriously from end to end of the field, all our long and narrow plats run across these irregularities and should be affected alike by them.

There may, however, be differences not easy to detect in the soil of different plats, by which the growth on one plat may be specially favored, or by means of which the fertilizer may be bet-

ter utilized. Whatever the reasons may be they will tell upon the results but will make less trouble for us the more careful we are as to everything that we can control.

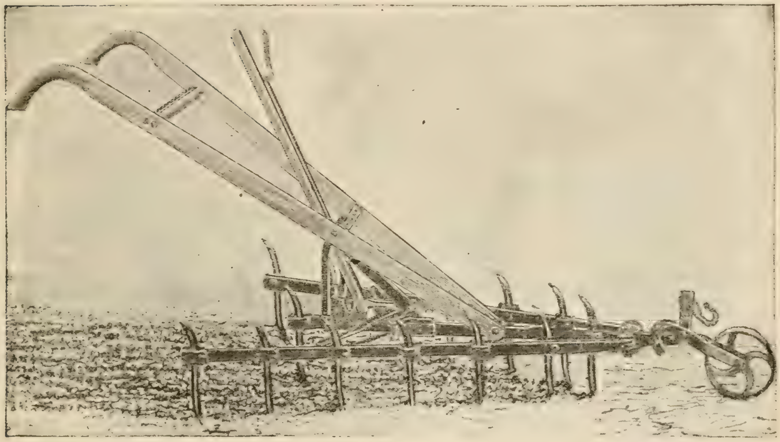
It is possible by a careful study of the results to correct some of the discrepancies. A few years ago a German agricultural chemist proposed a method for making such corrections by which the results could be evened up and made to show much more clearly what the soil and crop experimented upon require in the way of plant-food. The explanation of this method could not be made clear without illustrations, and such illustrations would be more interesting if drawn from actual experiments carried out in this country.

The writer of this paper will be glad to correspond with any farmers or horticulturists of this state who are disposed to try this method of field experiments, and answer any questions about the matter, go over the results obtained, apply the corrections according to the method above mentioned, and finally to issue in another bulletin early next year an account of all the experiments reported to him. G. C. CALDWELL.

**Bulletin 130.** **March, 1897.**

Cornell University Agricultural Experiment Station.
ITHACA, N. Y.
AGRICULTURAL DIVISION.

# Potato Culture.



By I. P. ROBERTS and L. A. CLINTON.

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124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk About Dahlias.
129. How to Conduct Field Experiments With Fertilizers.
130. Potato Culture.

# POTATO CULTURE.

Many experiments have been conducted by different experiment stations to determine the fertilizers best adapted to potatoes, various varieties have been tested, but comparatively little work has been done to determine the possibility of making available the potential plant-food already in the soil and to determine the effects of extra good tillage upon crop production. That the average yield of potatoes in New York is far below what it should be is shown by the last United States Census Report, in which the yield is given as 68.8 bushels per acre. In 1895, a most favorable year for potatoes, the average yield for the state was about 122 bushels per acre. With a view to determine the effects of tillage upon crop production the following experiment was planned.

The land selected for the work was a gravelly soil which had been subjected to a regular four-years' rotation, consisting of wheat, clover, corn and oats. In 1894, the land was all planted to corn. This corn land was fertilized with barn manure applied during the fall and winter of 1893-4 at the rate of about 10 tons per acre. In the spring of 1895 there were measured off 46 one-twentieth acre plats, and a portion of these plats was selected as the ones upon which to conduct an experiment in potato culture.

*The land was prepared for planting as follows: All plats were plowed late in the fall of 1894 after the corn was removed. In the spring, all plats were gang-plowed about May 1st, and the ground thoroughly harrowed, marked and furrowed with a double mold board plow and planted to potatoes May 3d and 4th. It should be remembered that this ground was a loose, open soil, and that before planting it was most thoroughly fitted. No amount of after tillage can ever make reparation for the failure to fit the ground properly before planting. Fig. 33 shows the gravelly nature of the soil. The photograph was taken in the fall of 1896 after the potatoes had been harvested This was the second time the field had been raked over and the stones removed.

*Prof. Geo. C. Watson was in immediate charge of the work in 1895.

33.—*Showing the gravelly soil on which the potatoes were grown.*

The record of planting for 1895 is as follows:

May 3, planted plats 21 and 22 to Rural New Yorker No. 2.

May 4, planted plats 23 and 24 to Orphan potatoes.

May 4, planted plats 25 and 26 to Rural New Yorker No. 2.

May 4, planted plats 27 and 28 to American Wonder potatoes.

The potatoes used for seed were large marketable ones and were cut to one strong eye to the piece and planted in rows 3¼ feet apart with the pieces 14 inches apart in the row. They were covered with a hoe to the depth of about four inches. The first cultivation was on May 10 with a Breed's weeder. It may be said that on this gravelly, loose soil, such an implement did good work, while on soils containing a large percentage of clay its work was not as satisfactory with us.

The second cultivation was given on May 17, when the spike-tooth harrow was used on all the plats. The importance of this early tillage before the potatoes are up can hardly be too highly estimated. The spring rains form a crust on the surface which needs to be broken up, innumerable small weeds which are just showing themselves through the soil are killed, a surface earth mulch is established which serves to prevent the loss of moisture by evaporation, and in many ways this harrowing of the ground before the potatoes show themselves is most beneficial to the success of the crop. Again on May 23, May 29 and June 6, all potato plats were cultivated with a spring-tooth cultivator. It will be noticed that up to this time the plats have been treated alike and already given as many cultivations as the potato crop ordinarily receives. From this time the tillage of the various plats, for comparison, varied in frequency. The complete record of the cultivation given is as follows:

May 3 and 4, all plats planted.

May 10, all plats cultivated with Breed's weeder.

May 17, all plats harrowed with spike-tooth harrow.

May 23, all plats cultivated with spring-tooth cultivator.

May 29, all plats cultivated with spring-tooth cultivator.

June 6, all plats cultivated with spring-tooth cultivator.

June 17, plats 21, 23, 25 and 27 cultivated.

June 24, all plats cultivated.

July 2, plats 21, 23, 25 and 27 cultivated.

July 9, all plats cultivated.

July 15, plats 21, 23, 25 and 27 cultivated.

July 23, all plats cultivated.

July 29, plats 21, 23, 25 and 27 cultivated.

August 5, all plats cultivated.

The tillage continued until the vines so covered the space between the rows that the cultivator could no longer be used without injuring the foliage.

The following table shows the results obtained from the different plats.

CULTURE EXPERIMENTS—POTATOES.

| 1895. | Number of cultures. | Yield per acre. Bushels. |
|---|---|---|
| Plat No. 21... | 13 | 378 |
| Plat No. 22... | 9 | 415 |
| Plat No. 23... | 13 | 319 |
| Plat No. 24... | 9 | 414 |
| Plat No. 25... | 13 | 304 |
| Plat No. 26... | 9 | 311 |
| Plat No. 27... | 13 | 350 |
| Plat No. 28... | 9 | 330 |

The average from plats given thirteen cultivations was 337.5 bushels per acre. The average for nine cultivations was 367.5. As has been mentioned, this year was especially favorable for potatoes and the average for the state was extra high, being 122 bushels per acre.

In 1896, the experiment was continued. The adjoining plats selected were a part of the series which had been planted to corn in 1894 and 1895. After the corn was harvested, all plats were drilled to wheat as a cover crop. This wheat made fair growth and when plowed under in the spring added some humus to the soil. Other than this no fertilizer or manure was used, and two crops of corn had already been removed since a light application of barn manure was made. That the results might be of more value, it was decided to give to some of the plats only ordinary tillage, to other plats extra good tillage and to others excessive tillage.

The record of the preparation of the soil for the potato crop of 1896 is as follows: The plowing was done as early in the spring

as the condition of the soil would permit and the land was immediately harrowed and rolled. Before planting, the Acme harrow was used to pulverize and loosen the surface soil. Rows were laid off at distances of 3¼ feet and opened with a double mold-board plow. The seed was from selected stock and was cut so that two or three eyes were on each piece. More care was taken to have each piece of potato of good size than to have a certain number of eyes to each piece. Seed was dropped at distances of 14 inches in the row and covered with a cultivator to a depth of about 4 inches. All plats were planted May 9 and harvested October 9. The complete record of the plats will be seen in the table below.

The first tillage was given May 20, before the potatoes were up, when all plats were thoroughly harrowed with the spike-tooth harrow. The cultivation was continued until August 6, at which time the vines so covered the space between the rows that tillage could no longer be continued without producing serious injury.

RECORD OF POTATO PLATS FOR 1896.

| Plat No. | Date of planting. | No. of cultivations. | Date of digging. | Yield per acre. Bushels. | REMARKS. |
|---|---|---|---|---|---|
| 6 | May 9 | 7 | Oct. 9 | 318.2 | Fertilized with 200 lbs. muriate of potash and 300 lbs. of acid phosphate. |
| 7 | " | 7 | " | 310.5 | Fertilized with 200 lbs sulphate of potash and 300 lbs. of acid phosphate. |
| 8 | " | 7 | " | 350.3 | Comparable. |
| 9 | " | 11 | " | 338.1 | |
| 10 | " | 3 | " | 280. | |
| 11 | " | 3 | " | 299.7 | Comparable. |
| 12 | " | 7 | " | 341.6 | |
| 13 | " | 7 | " | 334. | Variety test. |
| 29 | " | 7 | " | 360.6 | Fertilized with 200 lbs. of muriate of potash and 300 lbs. of acid phosphate. |
| 30 | " | 7 | " | 333.5 | Fertilized with 200 lbs. of sulphate of potash and 300 lbs. of acid phosphate. |
| 31 | " | 7 | " | 346.5 | Comparable. |
| 32 | " | 11 | " | 339. | |
| 33 | " | 3 | " | 245.8 | |

Those marked "comparable" are to be studied for the effect of tillage only.

In addition to the cultivation which was given these plats they were sprayed four times, once with Bordeaux mixture* alone and three times with a Bordeaux and Paris Green mixture.

In addition to the series of plats, a measured acre was selected which had been in timothy and clover the previous year. The soil was a clay loam and during the winter of 1895-6 was given a light top dressing of barn manure. In the spring the coarse material was raked off with a horse rake, and the land was fitted and planted to Rural New Yorker No. 2 potatoes. This acre received six cultivations and gave a yield of 314 bushels.

AVERAGE YIELD PER ACRE FOR 1895.

| | | |
|---|---|---|
| Plats receiving 13 cultivations, . . . | 337.5 | bushels. |
| " " 9 " . . . . | 367.5 | " |

AVERAGE YIELD PER ACRE FOR 1896.

| | | |
|---|---|---|
| Plats receiving 11 cultivations, . . . | 335.9 | " |
| " " 7 " . . . . | 343.1 | " |
| " " 3 " . . . . | 275.2 | " |
| The one-acre field, 6 cultivations, . . | 314. | " |
| Fertilized plats receiving 7 cultivations, | 330.7 | " |
| Average yield per acre for New York state (United States Census), 1890, . . . | 68.8 | " |
| Average yield per acre for New York state, 1895, . . . . . . . . . . | 122. | " |
| Average yield per acre for all plats and the one acre at Cornell University for 1895 and 1896, . . . . . . . . . . . . | 333.34 | " |

From these results we are led to conclude that in potato raising the matter of tillage is too often neglected. The results obtained two years in succession without any application of fertilizer show that the average yield of New York state is far below what it need be. The soil on which these experiments were conducted was not more rich in plant-food than the ordinary soils. The average analyses of forty-nine soils shows the following amount of potential plant-food to be contained in an acre to the depth of eight inches :†

* The Bordeaux mixture was made as follows: Copper sulphate 6 pounds, quick lime 4 pounds, water 45 gallons.

† For more extended soil analyses see Roberts' "The Fertility of the Land."

| | |
|---|---|
| Phosphoric acid, . . . . . . . | 4,219 lbs. |
| Nitrogen, . . . . . . . . . . | 3,053 " |
| Potash, . . . . . . . . . . . | 16,317 " |

An analysis of the soil from the plats on which the potatoes were grown shows the following amounts of potential plant-food per acre to the depth of one foot :

| | |
|---|---|
| Phosphoric acid, . . . . . . . | 3,784 lbs. |
| Nitrogen, . . . . . . . . . . | 3,074 " |
| Potash, . . . . . . . . . . . | 12,063 " |

This computed to a depth of eight inches, for comparison with the previous analysis given, shows the following amounts:

| | |
|---|---|
| Phosphoric acid, . . . . . . . | 2,523 lbs. |
| Nitrogen, . . . . . . . . . . | 2,049 " |
| Potash, . . . . . . . . . . . | 8,042 " |

It will thus be seen that with a soil containing little more than half the amount of potential plant-food ordinarily contained in soils, a yield was secured from three to four times the average yield of the state.

The fact has been mentioned that this soil was gravelly. In securing a sample for analysis we found in the surface foot 56.79 per cent of material fine enough to pass through a sieve of 18 meshes to the inch, and 41.85 per cent of gravel which would not pass through the sieve. The loss due to drying and waste was 1.36 per cent.

In the ordinary analysis of soils the gravel is not taken into consideration and only that part is now analyzed which passes through a sieve of 50 meshes to the inch. To determine more fully what potential plant-food was in the land, it was decided to analyze the gravel, or that portion which failed to pass through a sieve of 18 meshes to the inch. The result of the analysis showed the following amounts of potential plant-food locked up in the gravel of a surface foot of one acre of the land :

| | |
|---|---|
| Phosphoric acid, . . . . . . | 4,008.8 lbs. |
| Potash, . . . . . . . . . . | 11,329.8 " |

The manipulation that was necessary to cause the soil to pass through the sieve also broke down some of the gravel. It was found after sifting all the soil out that by working the remaining gravel with the hand a portion of it was so rotten that it

was easily disintegrated and fined, thus bringing into a more available condition its mineral fertilizing elements. By the frequent tillage given to the plats not only was nitrification promoted, but the mineral elements were partly liberated and made more available for the plant's use.

In a soil analyzing about one-half of the average in fertility, enough plant-food was liberated and made available by means of tillage alone to insure a vigorous plant growth. This partially explains why the application of chemical fertilizers on plats 6 and 7 and 29 and 30 failed to give any marked beneficial result. It is probable that had there been more moisture in the soil better results would have been shown from the fertilized plats, but under the existing conditions the fertilizer was applied at a loss as far as any effect was evident on the yield of potatoes. True, the fertilizers applied may be of some benefit to future crops, but the farmer can scarcely afford to purchase high-grade chemicals and apply them to his soil except for their immediate benefit to the succeeding crop, as it is well known that they become less readily available for the plant's use after having been in the soil for a considerable time. While this is true of the mineral fertilizers, it is more especially true of the nitrogenous, for if the most readily available form of nitrogen is applied, as in nitrate of soda, that portion of the nitrogen which is not made use of quickly by growing plants may be largely lost to the soil, being carried away by the drainage water.

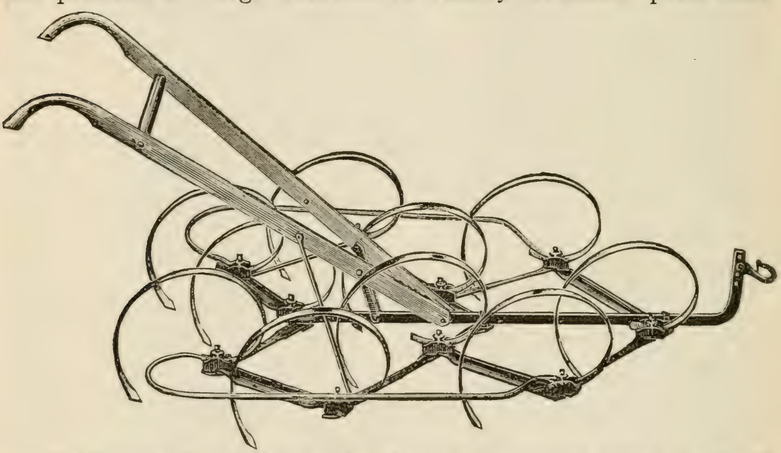
Shall the attempt be made, not only in potato culture, but with all farm crops, to substitute fertilizers for tillage? With potatoes at 25 cents per bushel and fertilizers at $25 per ton, is it good policy to purchase plant-food before an earnest effort has been made to utilize that vast store which nature has provided? If the effort has been made and the soil fails to respond satisfactorily, then it is not only justifiable, but it may be a wise policy to supplement the stores of the soil with additional readily available plant-food. The low average yield of the state is not so much due to lack of plant-food as to deficiency of moisture. It has been estimated by Professor King* that for

*The Soil, p. 155.

34.—*Tilling to conserve moisture in potato field.*

every ton of dry matter of potatoes produced there is required 422.7 tons of water. In the case of the average yield for 1896 with seven tillings when there was produced 343 bushels per acre, the amount of dry matter was 4,342.38 pounds, or 2.17 tons. To mature this amount would require some 917.25 tons of water. This was secured to the plants by early and deep plowing of the land to establish the earth mulch and to prevent loss of the spring rains, and then by frequent surface tillage the mulch was renewed to lessen the loss of moisture by evaporation.

The conservation of moisture by frequent tillage cannot be too strongly enforced. The liberal application of fertilizers, or the presence of large amounts of readily available plant-food



35.—*Cultivator well suited to potato culture during earlier period of growth.*

will prove of but little value if the moisture supply is deficient. The old notion that tillage must cease as soon as the potatoes blossom, is wrong. It should be continued as late in the season as the growth of the vines will permit. As the tops spread out and begin to cover the space between the rows, they partially shade the soil and thus lessen the loss of moisture by evaporation. The cultivator should be narrowed and the middle of the open space kept covered with a loose earth mulch (Fig. 34). The implement best adapted to this work is one having many small teeth so that it will leave the soil comparatively level. (See Frontispiece.) Fig. 35 shows an imple-

ment well adapted to potato culture during the early part of the season. The practice of cultivating potatoes once or twice and then finishing with the shovel plow, ridging the soil or hilling the potatoes, is most admirably adapted to hasten evaporation of the moisture and to produce a meagre crop, a large percentage of which is small and unmarketable.

With an abundance of plant-food and moisture for complete growth, another requisite is a healthy foliage, and to secure this requires careful attention. The earliest pest in the season of 1896 was the little flea beetles which made their appearance June 6. They work on the leaf and so puncture it that its vitality is injured and it is unable longer to properly perform its functions. A thorough spraying with Bordeaux mixture put an end to their depredations. The potato beetles made their appearance in large numbers about June 23. The second spraying was with Bordeaux mixture and Paris green, four to six ounces of Paris green to 40 gallons of the Bordeaux mixture. This was put on most thoroughly by means of a force pump. The Bordeaux mixture served to prevent early blight and the Paris green destroyed the beetles. A third spraying was given July 16, the materials used being the same as in the previous case. The late blight was almost entirely prevented and the Paris green served its purpose in keeping the beetles in check. On one plat, sprayed with the Bordeaux mixture but once, the vines died from two to three weeks earlier than on plats that had been thoroughly treated. The fourth and final spraying was given August 10th. Had this treatment not been given, increased tillage would probably have failed to produce such satisfactory results. The period of growth would have been lessened, the foliage would have been unhealthy, due to the attacks of blight and the flea beetle, and the potato beetles would have so destroyed the foliage that the manufacture of starch which goes on in the leaves in the presence of sunlight would virtually have stopped. The potatoes would have been but partially developed and inferior in quality, and instead of having only ten bushels of small ones to three hundred bushels of large ones, the percentage of small ones would probably have been greatly increased. It is the custom with some to plant their potatoes late in order to avoid the

ravages of the potato beetle, but the potato, except early varieties, in this latitude, needs the full season for its perfect development. It must be kept growing from start to finish and he who plants late to avoid the beetle is diminishing the yield very materially over what it would be were he to plant early, and then by spraying and by frequent tillage keep the plants in a healthy, growing condition until the potatoes are fully matured.

The question will arise with many potato raisers, "Will this extra care pay?" In 1895, the price for potatoes was almost unprecedently low, yet these, on account of fine quality and size, were sold directly from the field for 25 cents per bushel. The same thing was again true in the fall of 1896, and the average gross receipts from all plots, including the one acre field, was more than $80.00 per acre.

Within one mile of the University farm a man planted five acres to potatoes, and raised a total of 500 bushels, about 50 per cent of them small and unsalable, leaving a total of 250 bushels of marketable potatoes as the product of five acres. His soil was naturally more fertile than that of the University farm. The cost for plowing must have been about the same per acre, also the cost for seed and of planting and digging, and yet while his gross receipts were not more than $15 per acre the University receipts were $80.00 per acre. The problem for solution then is whether it is preferable to give superior tillage and care and harvest a crop of 300 bushels or more per acre or whether the potatoes shall be permitted to care largely for themselves and give a yield of from 50 to 100 bushels per acre. From these experiments and investigations in potato culture we have reached the following

CONCLUSIONS:

1. That most arable soils possess sufficient potential plant-food for a bountiful crop.

2. The average yield for the state is not more than about one-third what it should be, and what it would be were proper methods of cultivation practiced.

3. The low average in the state is due not so much to lack of potential plant-food as to the insufficient supply of moisture.

4. By frequent surface tillage, moisture may be conserved and potential plant-food made available.

5. Commercial fertilizers should be used only when the soil fails to respond satisfactorily to tillage, or to supplement manures and cover crops and stores of plant-food already in the soil.

6. Level culture is preferable to ridge or hill culture for conserving moisture. Ridges should only be used when the object is to relieve the soil of moisture as in low, damp fields.

7. All other requisites being present to insure a satisfactory crop, full success cannot be secured unless the foliage be kept healthy and intact.

I. P. ROBERTS.
L. A. CLINTON.

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Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

HORTICULTURAL DIVISION.

# Notes upon Plums

## FOR WESTERN NEW YORK.



By S. D. WILLARD and L. H. BAILEY.

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## BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
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CORNELL UNIVERSITY, Ithaca, N. Y., March 20, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

*Sir*:—This paper completes our survey of the stone-fruit industries of western New York, and it is submitted as a bulletin under the Experiment Station Extension Law. It is unnecessary to make any extended discussion of the methods of the tilling and fertilizing of plum orchards, for these general subjects have been fully gone over in previous bulletins upon fruit-growing. For three years the writer has been studying the plum industry of western New York, and he has also had the advantage of two or three crops upon the young orchard of the Experiment Station. The chief value of the bulletin, however, lies in the account of varieties which has been contributed by S. D. Willard, of Geneva; and Mr. Willard has also been most generous of suggestions upon plum-growing in general, and upon many other subjects, for several years. In fact, there is no one fruit-grower in the state from whom the writer has learned so much as he has from Mr. Willard; and it is therefore a satisfaction to be able to put on record some of the results of his long and profitable experience in the growing of plums for market.

L. H. BAILEY.

The pictures of plums in this bulletin are all life size, unless otherwise stated in the legend.

36.—*Reine Claude plums, eight years set.* (S. D. Willard.)

# NOTES UPON PLUMS.

## I. General Remarks.

Of all the important fruits, the common plum has the smallest American literature.* The time is perhaps not yet ripe for any extended treatise upon the plum, for in a large part of the country plum growing is yet in an experimental stage. In western New York, the business is reduced to a more definite and established basis than elsewhere in the country—unless possibly upon the Pacific coast—and a few notes upon this industry may therefore serve a useful purpose until a fuller treatise shall appear.

*The types of plums.*—The plum industry is very complex, because so many distinct species are concerned in the genesis of the cultivated varieties. In this state, only the European or domestic plums are grown to any extent, except that the Japanese types are now attracting much attention ; yet it will be worth our while to get a broad view of the subject by fixing the general basis of the plum industry in our minds. The plums cultivated in the United States belong to the following groups :—

I. Domestica or European types, *Prunus domestica*. Native to western Asia. Comprises the common or old-time plums, such as Green Gage, Lombard, Bradshaw, Yellow Egg, Damsons, and the like. The leading plums from Lake Michigan eastward and north of the Ohio, and on the Pacific slope.

II. The myrobalan or cherry plum type, *Prunus cerasifera*. Native to southeastern Europe or southwestern Asia. Much used for stocks upon which to bud plums, and also the parent of a few named varieties, like Golden Cherry ; and DeCaradeuc and Marianna are either off shoots of it or hybrids between it and one of the native plums. See Bulletin 38.

III. Japanese types, *Prunus triflora*. Probably native to China. The type seems to be generally adapted to the United States, and

* The only American book I know devoted wholly to the plum is Eliphas Cope's "Practical Treatise on Plum-Growing," New Lisbon, O., 1888, 16 mo. pp. 45.

will certainly be of great value to both the south and north. See our Bulletins 62 and 106 for full accounts of these plums.

IV. The Apricot or Simon plum, *Prunus Simonii*. Native to China. Widely disseminated in this country, but little grown except, perhaps, in parts of California. See our Bulletin 51.

V. The Americana types, *Prunus Americana*. The common wild plum of the north, and extending westward to the Rocky Mountains and southward to the Gulf and Texas. Admirably adapted to climates too severe for the domestica plums, as the plains and the upper Mississippi valley. See our Bulletin 38 for accounts of all the native plums.

VI. The Wild Goose or hortulana types, *Prunus hortulana*. A mongrel type of plums, comprising such kinds as Wild Goose, Wayland, Moreman, Miner and Golden Beauty. No doubt hybrids of the last and the next.

VII. The Chickasaw types, *Prunus angustifolia* (or *P. Chicasa*). Native to the Southern states, and there cultivated (from southern Delaware southwards) in such varieties as Newman, Caddo Chief, and Lone Star.

VIII. The Sand plum, *Prunus Watsoni*. Native to Kansas and Nebraska. A bush-like species, little known in cultivation. A hybrid of this and the Western Sand Cherry is the Utah Hybrid Cherry. See our Bulletin 70.

IX. The Beach plum, *Prunus maritima*. Native to the coast from New Brunswick to Virginia. In cultivation represented by the unimportant Bassett's American ; also as an ornamental plant.

X. The Pacific coast plum, *Prunus subcordata*. Native to Oregon and California. Sparingly known in cultivation, chiefly in the form known as the Sisson plum (var. *Kelloggii*).

With these ten types coming into cultivation in the rapidly enlarging fruit zones of our immense country, who can forsee what the final outcome as to types and varieties may be !*

The remarks in the present paper are meant to apply only to the domestica and Japanese plums, chiefly to the former. In

*For an historical and philosophical sketch of our plums, see Bailey, "The Survival of the Unlike," p. 418.

respect to varieties, it is difficult to make any classification of those of the domestica stock. Perhaps the best that could be done would be to make four loose groups, as follows:

1. Damsons comprising very small firm plums of various colors, generally borne in clusters, the leaves mostly small. The run-wild plums of old roadsides and farmyards are mostly of the damson type. (Fig. 46 and title page.)
2. The green gages, comprising various smallish, green or yellow-green plums of spherical form and mostly of high quality. Reine Claude is the commonest representative of this group in this State. There seems to be no specific Green Gage generally propagated in this country. The name has now come to represent a class of plums.
3. Large yellow plums, such as Coe's Golden Drop, Washington, and the like.
4. Large colored plums, including the various red, blue and purple varieties, like the blue prunes, Lombard, Bradshaw, Quackenboss, etc.

In respect to hardiness of the different types of plums, it may be said that at Cornell the Japanese and domestica varieties are about equally resistant to cold. Neither of them bore fruit last year, but the winter of 1895–6 was one of very unusual severity. The Americana types are very hardy. Fig. 37 shows sprigs of the three types taken at blossoming time in 1896. The upper shoot is Abundance (Japanese), the middle one Jefferson (domestica), and the lowest one Quaker (Americana). In the two first, the fruit-spurs were entirely killed. Although the Americanas are so very hardy, we do not recommend them for market cultivation in western New York because they are inferior to the domesticas and the years are very seldom in which the domesticas are injured seriously by cold.

The leading type of plum for western New York will no doubt always be the domesticas. The Japanese varieties are important because they add variety to the list, and especially because they are rich in very early kinds and the fruit is so firm that it carries well; aside from this, the trees are vigorous and very productive, and they are less liable to the attacks of the black-knot and the shot-hole fungus than the domesticas are.

*The plum orchard.*—Coming now to the general question of plum growing, it may be said that the plum is emphatically a special fruit ; that is, it is one which does not have a regular standing in the market as pears, apples or even peaches have, but is more or less dependent for its sale upon the general supply of other fruits. In other words, it is a fruit of secondary import-

37.—*A condition, not a theory. Showing how the winter of 1895-6 used up the fruit-spurs of Japanese and domestica plums, but did not injure the Americanas.*

ance, so far as the market is concerned. This being the case, it will readily be seen that it is not a difficult matter to overplant for the plum market. In western New York, the industry has been developed to a very important extent, but the production of fruit has probably not yet reached its zenith. Many of the orchards have been planted with no particular forethought, but

largely because some one else had done well with his plantation. It would be easy to figure up the prospective crops from the plum trees which are now growing in western New York and to see that the product would very likely over-stock the market. But it must be remembered that probably not more than half of these trees will ever produce full crops of fruit. The same remark will apply to any kind of fruit which is set in large quantities. The success of fruit-growing is so intimately connected with the thoroughness, care and business ability of the grower himself, that one can never prophesy what the results of any fruit industry are likely to be. In every fruit business there are likely to be a great many failures, from the commercial standpoint, and only a few pronounced successes.

The plum thrives upon a variety of soils, but it generally does best when planted upon clay loam. It usually thrives best upon lands which are suited to pears, or upon the heavier lands which are adapted to apples. Yet there are many varieties which thrive well upon lands which are comparatively light and sometimes almost sandy.

The stocks upon which plums are grown are very various. By far the greater number of the trees in the north are now grown upon the myrobalan stock, which is a species of rather slow-growing plum, native to southeastern Europe and southwestern Asia. This is the stock which is sometimes recommended in the older fruit books for the making of dwarf trees; but unless the top is kept well headed in, the trees generally make normal growth upon it. Trees grown upon this root are usually larger and finer at one or two years of age than those grown upon other plum stocks, and the probability is that they are nearly as useful from the grower's standpoint as any other. However, there are some varieties which overgrow the myrobalan, and the stock is very likely to sprout from the ground and thereby cause trouble. I am convinced that the most ideal stock, from the standpoint of the grower, is the domestica plum itself, but it is more difficult to secure seeds of it, the stock is more variable and it is more likely to be injured in the nursery row by the leaf fungi; therefore, as a matter of practice, the myrobalan has very generally supplanted it. In the southern states the peach is largely used as a stock

upon which to grow plums and it seems to be gaining favor in the north. It is undoubtedly a very excellent stock for sandy lands, and, in fact, is probably more preferable for such lands than the myrobalan itself. Some varieties—of which the Lombard and French Damson are examples—do not take well upon the peach. The Japanese plums are commonly worked upon the peach stock and they seem to make an excellent union with it and to give every promise of being hardy and durable. The Marianna stock, which is much recommended in the south, has not found great favor in New York.

Many of the varieties of plums are such slow and crooked growers in the nurseries that it is advisable to graft them or bud them upon some strong and straight stock. The Lombard is no doubt the best stock for this purpose which is now grown by nurserymen. The old Union Purple is one of the very best of stocks, but it is not grown much at the present time. All such varieties as Reine Claude, German Prune, Copper, etc., are probably best when top-worked upon some such stock.

Plum trees are usually planted when two years old from the bud, although some of the strong-growing kinds may be planted at a year old with the very best results. As a rule, plum trees are planted about as far apart as peaches are, that is, from 15 to 18 feet apart each way. Many growers prefer to plant them closer one way than the other and eventually to stop cultivation in one direction. If this system is used, they may be placed 18 or 20 feet apart one way, and from 10 to 12 feet the other way. The trees are pruned in essentially the same way that apple trees are, when planted. It is generally advisable to start tops as low as possible and yet allow of the working of the curculio catcher below them. This means that the limbs should start out from three or four feet above the ground. With the modern implements and methods of tillage, there is no inconvenience in working the land if tops are started as low as this.

The subsequent pruning of the plum tree has no special difficulties. About four or five main limbs are allowed to form the framework of the top, and in most varieties, especially those which are not very tall growers, the central trunk or leader may be allowed to remain. There is constant demand for information

as to whether young trees should be headed-in. There can be no positive answer to this question. If the trees are growing very vigorously, so that they become too tall and whip-like, it is best to head them in ; but it must be remembered that this redundant growth commonly ceases and the tree begins to spread when the bearing time arrives. If trees are making too vigorous growth, the real corrective of the difficulty is to stop the growth by withholding fertilizers or cultivation rather than by heading-in the tree. Vigorous heading-in only makes the growth the stronger. All this is a very different matter from the customary heading-in of old trees. Some growers prefer to let a plum tree take its natural open, spreading growth, whilst others desire to keep it sheared in to allow the trees to be planted closer together and to keep the fruit nearer the center of the tree. This is very largely a matter of personal preference and there are probably no very decided advantages in either system when it is carried out systematically and conscientiously. For myself, I believe that the heading-in of plum trees is practiced to too great an extent in western New York, but I should by no means be dogmatic in this opinion. It should be said that the plum tree will need pretty careful attention from year to year to keep the top in shape, to cut out and paint over all injured places and in other ways to protect the tree from accidents and from injuries of storm and insects.

In common with all fruits, the plum demands good tillage and liberal feeding if satisfactory results are to be obtained. The extended remarks upon the tilling and fertilizing of fruit lands which are made in our Bulletins 72, 102, 103, and also in 119 and 120, apply with full emphasis to the plum. Well-tilled trees should begin to bear when three years set, and, at eight and ten years of age, the prolific varieties should be bearing three bushels of first quality fruit in every good year.

*Insects and diseases.*—In respect to insects and diseases of the plum, it will not be necessary to say much upon this occasion. The black-knot is fully treated in our Bulletin 81. It is only necessary to say in passing that the knot is best kept in check by systematically cutting it out whenever it is seen. At all events, the grower should go over his orchard for it in the summer time

and again as soon as the leaves are off in the fall. If trees are thoroughly sprayed every year with Bordeaux mixture for the leaf-blight fungus, the black-knot will make comparatively few inroads into the orchard.

The blight which causes the leaves to fall in August or September is one of the most serious diseases of the plum orchard; but the disease can readily be kept in check by thorough spraying with Bordeaux mixture two or three times during the summer. We have found, at Ithaca that we can hold the leaves on until frost by sprayings which have begun about two weeks after the blossoms fall, and repeated two or three times during the season. A somewhat full account of these experiments will be found in our Bulletin 86.

38.—*Fruit-rot of the plum. The upper spur is dead, probably killed by the fungus.*

The fruit-rot is another serious difficulty of the plum. This is the work of a fungus. Many times the dead and dried fruit may be seen hanging upon the tree all winter, as shown in Fig. 38; and in such cases it is very likely that the fruit-spur will be killed as the upper one in the picture has been. In handling this disease, the first consideration is the fact that some varieties are much more susceptible to it than others are. The Lombard is one of the very worst. Again, if the fruit grows in dense clusters, the disease is more apt to be severe. The thinning of the fruit, therefore, is one of the very best preventives of the spread of the disease and at the same time, also, one of the most efficient means of increasing the size, quality and salableness of the product. It may, therefore, be expected to pay in

two directions. The specific treatment for the disease is to spray with Bordeaux mixture, applied in about the same manner as for the leaf-blight fungus. The treatment of this disease is more specifically explained in our Bulletin 86.

The recent incursion of the plum scale in western New York, which has created so much alarm, is fully treated in our Bulletin 83. This insect, although formidable, may be kept in check almost completely by thorough sprayings with strong kerosene emulsion in the winter time.

There still remains the curculio, or the insect which is the parent of the worms in the fruit. A full report upon this insect may be expected at a future time. It is enough for the present purpose to say that the mature beetle lays the eggs in the fruits when they are very small, usually beginning its work about as soon as the flowers fall. These eggs soon hatch and the little maggot bores into the fruit. Those fruits which are attacked whilst very young ordinarily fall from the tree, but those which are attacked when they are half or more grown may adhere to the tree but are wormy and gummy at the picking time. The mature beetles are sluggish in the mornings and are easily jarred from the trees. Taking advantage of this fact, the fruit grower may jar them into sheets or a large canvas hopper which is wheeled from tree to tree upon a wheelbarrow-like frame and under the apex of which is a tin can into which the insects roll. One of these hopper machines is seen in Fig. 39. There is a slit or opening in one side of the hopper which allows the tree to stand nearly in the middle of the canvas. The operator then gives the tree two or three sharp jars with a padded pole or mallet. The edges of the hopper are then quickly shaken with the hands and the insects roll down into the tin receptacle. In this receptacle there is kerosene oil, or it may be emptied from time to time. Just how long this machine is to be run in the orchard will depend entirely upon circumstances. It is advisable to use the catcher soon after the blossoms fall for the purpose of finding out how abundant the insects are. If a few insects are caught upon each tree, there is indication that there are enough of the pests to make serious trouble. If after a few days the insects seem to have disappeared,

it will not be necessary to continue the hunt. In some years, especially in those succeeding a very heavy crop, it may be necessary to run the curculio-catcher every morning for four or five weeks; but, as a rule, it will not be necessary to use it oftener than two or three times a week during that season; and sometimes the season may be shortened by one-half. The insects fall most readily when the weather is cool and it is, therefore, best to

39.—*The Geneva type of curculio-catcher.*

get through the whole orchard, if possible, before noon. Upon cloudy days, however, the insects may be caught all day. Although this may seem to be a laborious and expensive operation, it really is not so. A smart man can attend to 300 to 400 full-bearing trees in six hours, if the ground has been well rolled or firmed as it should be before the bugging operation begins. But whether the operation is troublesome or not, it is the price of plums and the grower must not expect to long succeed without it. The same treatment is essential to the saving of peaches and rarely, also, of sour cherries.

*Varieties.*—The most popular variety of the plum, and also one of the poorest, is the Lombard. Its redeeming merits are its great productiveness and the vigor and hardiness of the tree. The fruit is of o quality, it comes at a season when the market is full of plums and other fruits, it is very susceptible to the leaf-blight fungus and the fruit-rot, and its color is not of the best. The very fact that it is the commonest and cheapest plum would seem to indicate that it is not the best variety from which to make the greatest commercial success. I am convinced that the Lombard has been greatly overplanted; yet, I know of many orchards of it which are very successful commercially. In western New York the best markets are likely to be found for the early and late plums, and for those which have very pronounced colors, especially those which are dark red or purple. Some of the dark yellows are also very excellent for market fruits. Fruits of nondescript colors, like those which border on the ill-defined reds, the browns and the lemon yellows, are usually not profitable. There is some exception to all this in the case of the Reine Claude, which is a yellowish-green plum; but its great merit as a culinary variety and its established reputation save it from the general condemnation of plums of that class. There is also an exception in the small Damson plums which are highly esteemed in some markets, especially in Boston, for culinary purposes.

It would be impossible to give any list of varieties which would be adapted to any particular orchard. The question of varieties is very largely a personal one. Very much depends upon what ideal the grower has in his mind, and also upon his soil and location and the like. Amongst the plums which can be most confidently recommended for market in western New York are the following: Field, Bradshaw, Coe's Golden Drop, Hudson River Purple Egg, Italian Prune, Empire, Grand Duke, Arch Duke, Monarch, Gueii, Peter's Yellow Gage, Reine Claude and Copper. Amongst the Damsons, the French and the Farleigh are perhaps the best. Of the Japanese plums, the only ones which I would care to recommend for profit in western New York at present are the Red June, Abundance, Burbank and Chase. The Red June promises to be the best very early market plum for this region which I know. So far as known, the domestica and Japanese plums are self-fertile, but it is always the safest course to plant varieties in alternate rows.

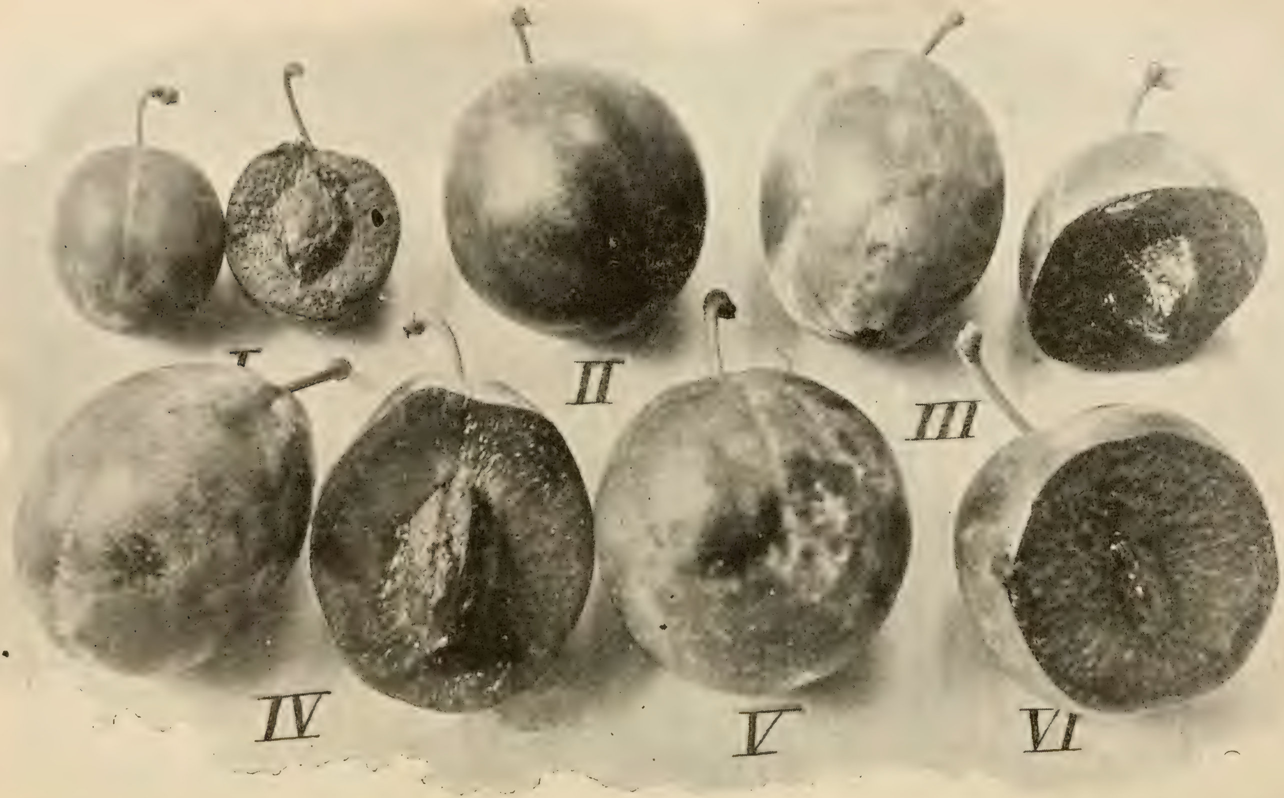
## II. VARIETIES OF PLUMS IN WESTERN NEW YORK.

*By S. D. Willard.*

An experience of a quarter of a century in cultivating the plum has afforded convincing proof that, upon my soil at least, this fruit is like many others in the fact that the list of varieties adapted to profitab e orchard production is limited in number. Some are tender in the wood, others defective in their foliage,* others maturing at the wrong period or possessed of other weak points that render them unfit to be grown in the commercial orchard of western New York. It will readily be seen that the result of my experience, as demonstrated in testing the various sorts of plums, has been with reference to the one idea of profit. Believeing that the descriptions contained in our fruit works and nursery catalogues,—the latter being in the main copied from writings regarded as authority on these subjects,—are oftentimes misleading to the planter and are followed by ventures that are alike unsatisfactory and unprofitable, I have taken pains to make descriptions directly from life. All enjoy the delicious quality of a favorite product, but how often the question is lost sight of, as to whether it can be grown in quantity and at a price that will enable us to supply it to others at a profit over and above the cost of production !

Soil and surroundings have their influence upon the health, vigor and productiveness of a variety; hence it is frequently found that a fruit may be a failure on one soil and a success elsewhere. This feature has been very marked in the cultivation of the strawberry, and it is likewise true of the plum. Careful observation has led me to believe that any tree which has an inherent weakness, either in foliage or wood, is to be looked upon with suspicion when considered as an orchard sort for the average

* Mr. Willard prefers to grow varieties which are not subject to the leaf-blight fungus, rather than spray for the disease. He has given particular attention to the choosing of resistant varieties, and this will account for his condemnation of certain varieties which are otherwise desirable. A tree which is seriously attacked by the leaf-blight is very likely to be injured by the succeeding winter.—L. H. B.




40.—*Various types of plums. I., French Damson (two fruits); II., Quackenboss; III., Hudson River Purple Egg (two fruits); IV., Grand Duke (two fruits); V., Monarch; VI., Diamond.*

planter. Being desirous of securing the largest line of varieties that might be of value, a selection was made from foreign catalogues of sorts highly commended, and these have been tested with results which, as will be seen, are not entirely satisfactory, as but few out of the entire number have made a record that would warrant their cultivation on any extended scale.

In the subjoined list, nineteen foreign varieties which I have thoroughly tested from direct importations are marked with an asterisk (*).

* *Arch Duke.*—A large, dark colored, very prolific plum, ripening about the 25th of September at Geneva and often hanging much later ; flesh hard and a good shipper, hence an excellent late market variety for the orchardist and should be more largely planted. I bespeak for this variety future popularity. Originated by Thomas Rivers, Sawbridgeworth, England. See Grand Duke.

*Baker Prune.*—Origin, Collingwood, Canada. We obtained this variety several years since and from observing it as top-grafted in our orchard are much pleased with its habits of growth. It seems to have been grown many years where it originated and is said to be hardy and prolific. Fruit resembles the Italian Prune in color and quality, perhaps a trifle smaller and about two weeks later in ripening. Should its good characteristics be maintained upon further trial, I should regard it as the best of prunes for the commercial orchard.

* *Biltern.*—Another plum highly commended abroad for its excellence in quality and great productiveness, traits which were fully confirmed during the short period of existence of the trees after they began to make a crop, but they lacked the robust character required to maintain themselves, and, like their companions, found their way to the brush heap after setting their third crop.

*Bradshaw* (*Niagara*).—A variety now very well known in all the plum-growing regions of the United States. Unsurpassed for beauty and productiveness as well as great hardiness of tree, with a foliage so perfect as to contribute in an essential degree to its health. During the period of twenty-two years in which I have fruited this variety, I have never known it to cast its foliage prematurely ; hence, the oldest trees are apparently as healthy as though they had never borne a crop of fruit. Fruit large, oval, often with a slight neck ; skin reddish purple ; flesh yellow, rather coarse but juicy and good ; ripening from tenth to twentieth of August at Geneva. Its beauty as a market sort is unsurpassed and were its period of ripening in the month of July or past the middle of September might be regarded as one of the most desirable of all plums for the commercial orchard. It has been planted very extensively, and it is a question whether there are not enough now growing to meet the demands of the city fruit stands for years to come, as it cannot be regarded as a desirable sort for peserving purposes.

*Canada Orleans.*—A very productive variety of medium size obtained at Hamilton, Ontario. Skin light green to yellow shaded to light purple in the sun ; quality good ; ripening August 15th to 20th. Tree hardy, bearing good crops alternate years. Of no special value to the market grower.

*Coe's Golden Drop.*—Of English origin. Fruit large, oval or short egg-shape ; skin light yellow ; flesh rich and quality excellent when well ripened ; requires a quick soil and favorable season to ripen it well. Tree slow, poor grower but very hardy ; has produced best with me when top-worked on other strong growing sorts. In unfavorable seasons has shown inclination to rot, but it may be regarded as one of the good yellow plums. This plum, or something exceedingly like it, has been sent out on the Pacific Coast as a prune.

*Coe's Late Red.*—An English variety. Fruit medium size ; skin light purplish red ; flesh yellow ; very firm and excellent for preserving or shipping ; productive and late, ripening in October and frequently hanging well into November. The late John J. Thomas once said to me, if he could have only one variety of plum, this would be his choice because of its lateness and value for culinary purposes. As a tree, its growing habits are unsatisfactory, and, therefore, it will never be popular with nurserymen. It will do best top-worked on vigorous growing sorts.

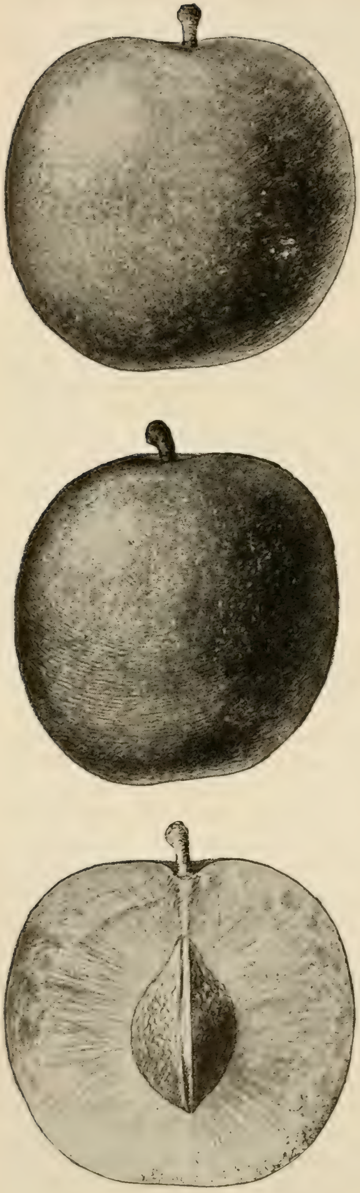
*Copper* (French).—A late plum, very productive and profitable, ripening last of September, frequently hanging into October ; fruit medium, dark copper color and valuable for preserving. Tree a poor grower ; hence, can rarely be found in hands of nurserymen. It should be worked on some strong growing sort. A fine shipper and usually sells at good prices. [Fruit globular, copper-purple with thin bloom. Valuable because of extreme lateness. —L. H. B.]

*Cruger's Scarlet.*—A variety that several years since was grown largely in the vicinity of Geneva. The name indicates the color, which makes it attractive when grown exposed to the sun, but the size and quality being against it both for market and family use, it has been supplanted by others of more value.

* *Curlew.*—An enormous bearer of attractive large, deep blue fruit, ripening just before the middle of August ; but the foliage drops early, preventing at times a fair maturity of the crop and unfitting the tree to withstand the severity of our winters.

* *Czar.*—Origin, England. A large, early, purple plum, rich and good ; ripening about July 25th ; very productive. Defective in foliage ; though fine in quality of fruit, it is of no value. Its extreme earliness would make it valuable were it more hardy.

**Diamond* (Fig. 40, VI.).—Large, dark purple, with a beautiful bloom which renders it very attractive in appearance and sought for on the markets. Tree very productive, hardy and one of the best of English introductions, and, in my opinion, when better known, will be highly regarded as an orchard variety.



41.—*Empire plum.*

*Duane's Purple.*—Fruit very large, oblong; skin reddish purple; flesh yellowish, juicy and sweet, quality good; desirable for the garden or home use, but ripens with too many others to have market value, being at its best between 8th and 15th of August here. This is one of the old varieties that is rarely heard of to-day.

* *Early Rivers.*—Of English origin. Medium size, oval; purple; rich and juicy; perfect free stone; ripening last of July. Very productive, but the tree has been very tender and for this reason has been discarded, and I believe would be of no value to anyone.

*Empire* (Fig. 41).—Originated in Cortland county, in this state, and at one time sent out under the name of the Rood plum. Oval; color dark purple; large; quality good; tree hardy, productive and vigorous. Fruit ripening about September 5th to 10th. A variety that may become a popular orchard sort. See Shipper's Pride.

* *Farleigh Damson.*—Fruit dark purple, a little smaller than Shropshire (which see), intensely productive and one of the most hardy of all plums in bud and wood. It is valuable as an orchard tree and when better known will be in demand.

*Field.*—A seedling of Bradshaw; ripening ten days earlier, of same large size and color, except that it is darker and not so attractive. The fact, however, that it comes upon the market earlier adds to its value. It originated in Schoharie County, New York. It has an excellent foliage and ripens an extremely hard bone-like wood well calculated to withstand injury from severe cold. It sets a heavy crop in alternate years.

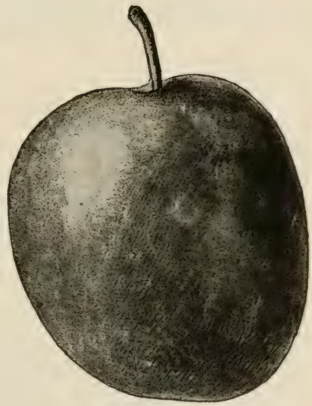
**French Damson* (Fig. 41, I.).—One of the largest of the Damson family.

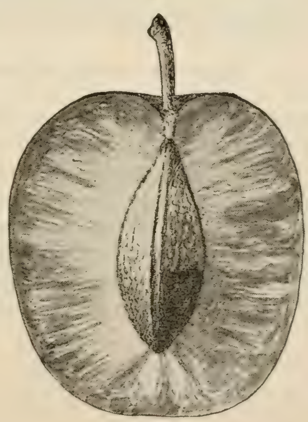
Dark copper color, ripening about September 7th, and carries a foliage so perfect as to insure complete ripening of its wood. A very valuable market variety which is but little grown.

*General Hand.*—Fruit large; skin deep yellow when ripe; rather coarse, and not sufficiently productive to be regarded with favor by the orchardist. It ripens early in September, but trees of large size,—fifteen to twenty years of age,—have never produced sufficient to pay for the use of the ground they occupy and have recently been grafted over to more valuable sorts.

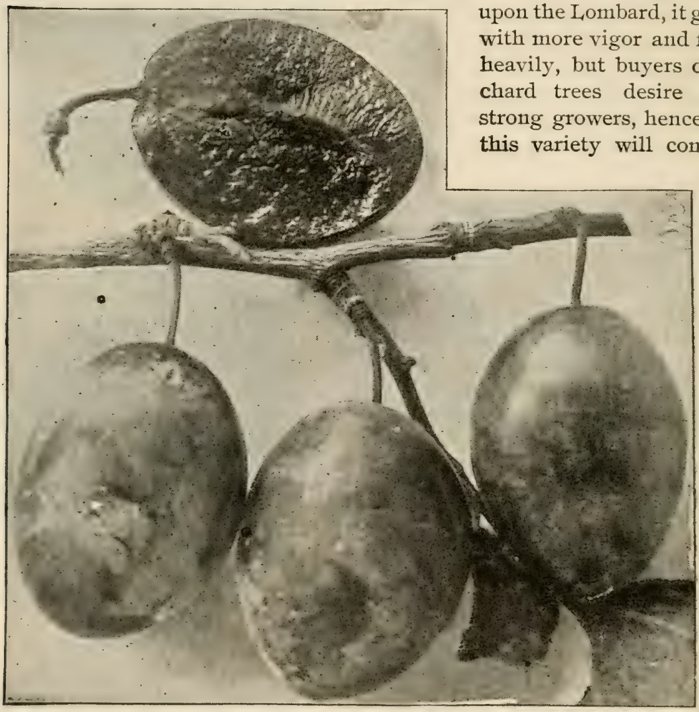
*German Prune* (Fig. 43).—So many plums are in cultivation under this name that it seems difficult to fix the title. I have no less than six, all differing more or less in habit of growth, and yet the fruit deserves the name of a German Prune. These varieties have been obtained from parties in different sections, each claiming his as the best. Fruit long and oval, apt to be swollen on one side; skin purple with a fine bloom; ripens from September 1st to 12th. This prune is valuable for a marked sort or for home use and sells at outside prices. As a rule, the trees are poor growers and rarely afford satisfaction to those who desire to secure the growing habits of the Lombard in all of the plum family. See Italian Prune and Weedsport Prune.

*Giant Prune.*—One of the new productions of Luther Burbank, of Santa Rosa, California, to whom I am indebted for the satisfaction of having fruited it from buds sent me a few years since. I have found it fully equal in size and quality to specimens grown on the Pacific Coast. It may be classed as very large, oval, dark purple plum of excellent quality. The tree, as grown top-worked upon Lombard, seems to be of good growing habit.





* *Grand Duke* (Fig. 40, IV.).—Originated and sent out in England by same party that sent out Arch Duke and Monarch. Mr. Thomas Rivers has furnished to the world these three of the largest and most beautiful late plums of recent introduction. The Grand Duke is a very large purple plum, so attractive in its appearance as to be a fine market sort and apparently well adapted for general cultivation over a wide area. Unfortunately, the tree is not a strong grower and makes surface slowly on which to spread a crop of fruit. When top-grafted upon the Lombard, it grows with more vigor and fruits heavily, but buyers of orchard trees desire only strong growers, hence this this variety will come to



43.—*The normal or predominant type of German Prune.*

the front slowly. It ripens from Sept. 15th to 20th at Geneva, and can be classed as belonging to the late-ripening sorts.

*Green Gage.*—The standard of excellence in the opinion of many. Fruit round; small; skin green; flesh pale green, melting and juicy, parting freely from the stone. Tree an abundant bearer, but so dwarfish in its habits of growth that no nurseryman will attempt its propagation; hence, but little is known of it at the present day. Indeed, the variety is practically obsolete. It ripens about the middle of August. A fine sort to be found in

a list for home purposes and can be best grown by top working upon Lombard or some strong growing variety. A historic plum, of Old World origin.

*Gueii.*—Fruit large, oval; skin dark purple, covered with a thick bloom. Tree very hardy and productive; strong grower; quality fair, chiefly valuable for culinary purposes, ripens about August 25th, or a little too early for the market orchard. It had its origin at Lansingburg, N. Y. I had the honor of introducing this variety at Geneva, having obtained the buds at Athens, N. Y., about twenty-two years since. [Fruit pointed or conical, —L. H. B.]

**Heron.*—Fruit large, light-purple and red; a free-stone of fine quality, ripening early in August. A good producer, but the foliage has shown a weakness that seemingly unfits it as an orchard variety for our latitude.

*Hudson River Purple Egg* (Fig. 40, III.).—A variety, as the name indicates, having its origin on the Hudson River. Fruit long and oval, dark purple, ripening Sept. 1 to 10; good producer only when the tree has age, and the most vigorous of all plums as a grower. It requires an annual cutting-in of the young growth to keep it within bounds until heavy fruiting checks the growth. One of the most valuable of its season as a market sort, but inclined to suffer from the depredations of the black-knot in seasons favorable for the development of the disease. Its productiveness is greatly increased by working on other sorts.

**Ickworth Imperatrice.*—A roundish-oval, purple, medium sized, rich, juicy plum, and when well ripened most excellent for eating. Sets fruit rather scattering and will hang a long time on the tree. Rather slow grower, but very hardy. It is doubtful whether it will become a popular market sort, but holding well into October makes it desirable.

*Imperial Gage.*—Origin, Flushing, Long Island. Fruit medium to large, oval, green, inclined to yellow when ripe, rich and juicy, excellent in quality and of deserved popularity in a general collection; has not proved a valuable market variety with me; and as the demand for it is becoming less annually, it is fair to presume that the experience of others is the same as my own in regard to its value in the commercial orchard.

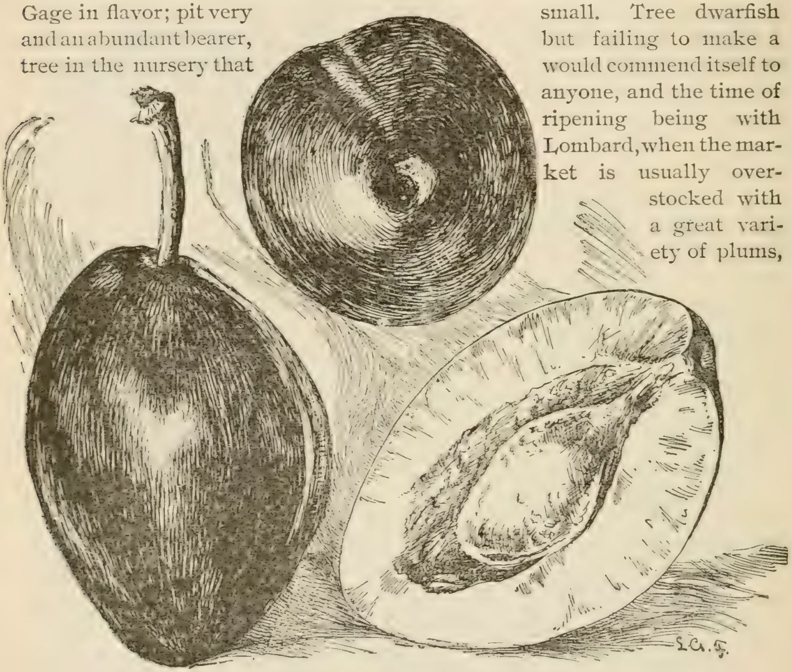
*Imperial Ottoman.*—A very early ripening variety of excellence, but little known. Fruit medium in size; round; skin dull yellow; flesh juicy, sweet and good. Tree hardy and very productive. Fruit ripens last of July, and should be more generally known. Ripening early, it sells readily in the markets and a few trees that we have fruited for fifteen years have been a good investment; and yet we doubt whether a single tree could be found growing in a nursery in the state.

*Italian Prune*, or *Fellenberg* (Fig. 44).—One of the best of the prune family. Fruit large, oval; skin dark blue with fine bloom; fine to eat from the hand or for preserving and sells at highest price in market; often hanging into late September. [Tree a round-headed grower, with well-marked foliage. Fruit long and blunt-pointed, unequal-sided, blue with a very dense bloom, a third larger than most of the strains which are grown under the

name of German Prune. In western New York it ripens in mid-September. Much prized by commercial plum growers.—L. H. B.]

*Jefferson.*—One of the choice table plums; large; skin yellow; excellent in quality but lacking the essentials demanded as a market sort; hence, is not in demand and will soon be unknown. Ripens a little later than Washington (which see.)

* *Late Transparent.*—Fruit large; round; greenish yellow changing to purple according to sun exposure; flesh firm and juicy, nearly equal to Green Gage in flavor; pit very small. Tree dwarfish and an abundant bearer, but failing to make a tree in the nursery that would commend itself to anyone, and the time of ripening being with Lombard, when the market is usually overstocked with a great variety of plums, it has been voted as being of too little value for general culture and is dropped from our list.



44.—*Italian Prune, or Fellenberg.*

*Lombard.*—Originated in the eastern part of this state. Tree one of the most vigorous of the plum family and perhaps more generally known than any other. Skin dark red, often green in the shade. It is inclined to over-production; hence, rarely makes a crop except in alternate years. To get best results, fruit should be thinned out one-half. Its period of ripening—middle to last of August—is such as to bring it in competition with other fruits, when it sells at low prices. Quality good when well ripened, but chiefly in demand by the canning factories as a low-priced plum.

*McLaughlin.*—A variety originating in Maine and disseminated by a party whose name it bears. Fruit medium to large; nearly round and flattened at both ends; skin tender, yellow and apt to be red in the sun; flesh firm, sweet and when perfectly matured excellent; ripening last of August. Tree hardy and productive. A desirable sort to be grown in a small way in a home collection, but for some reason choice fruit of this variety has met with no favor upon markets where I have placed it; hence, I cannot commend it to the commercial orchardist. Its period of ripening may be one reason of its lack of popularity. At one time I had in fruiting a large number of trees, many of which have been top-worked over to varieties of greater value. [See history and picture of this variety in American Gardening, May, 1893, p. 299, by Professor W. M. Munson.—L. H. B.]

**Mallard.*—Fruit large; deep purple; flesh very rich and juicy; free-stone; tree fairly productive. Season about middle of August, but the tree lacks the vigor required to withstand our trying climate; and while it might be looked upon with favor in a collection of an amateur by reason of its quality, to the commercial orchardist it would have no value. English.

*Middleburg.*—A plum of recent introduction from Schoharie County, N. Y. Tree very rugged, setting a full crop in alternate years of large, fine fruit that ripens late in September, often holding well into October. Skin yellow shaded with lilac and purple. Its attractive color and late ripening make it a valuable market sort, particularly on account of its hardiness. Its defect is a foliage that is inclined to drop in unfavorable seasons.

**Monarch* (Fig. 40, V.).—Fruit very large; roundish oval; dark purplish blue; perfect free-stone. Tree robust, with a dense foliage, and an abundant bearer. In period of ripening, a little later than Grand Duke. One of the valuable English plums originated and introduced by Mr. Rivers. See Grand Duke.

*Monroe Egg.*—Origin, Monroe County, New York. Fruit medium size; oval; skin greenish yellow; flesh rather firm and sweet; skin rather tough, which makes it a favorite with the canners. It produces a heavy crop alternate years and ripens about with Imperial Gage, from last of August to September first. We have a few trees that have been fruiting for over twenty years but as it is not well received upon the city markets, there is no reason to commend it to the notice of fruit-growers. Years since it was in cultivation very generally by nurserymen, while to-day it can scarcely be found. Often called the Monroe.

*Moore's Arctic.*—A plum received from Prince Edward's Island several years since and while highly regarded there and elsewhere north by reason of its hardiness, seems to have no qualities that should make it valuable to the commercial grower here. A medium size, dark colored variety, ripening last of August and in quality below the average of those that can be denominated good. We have abandoned its culture.

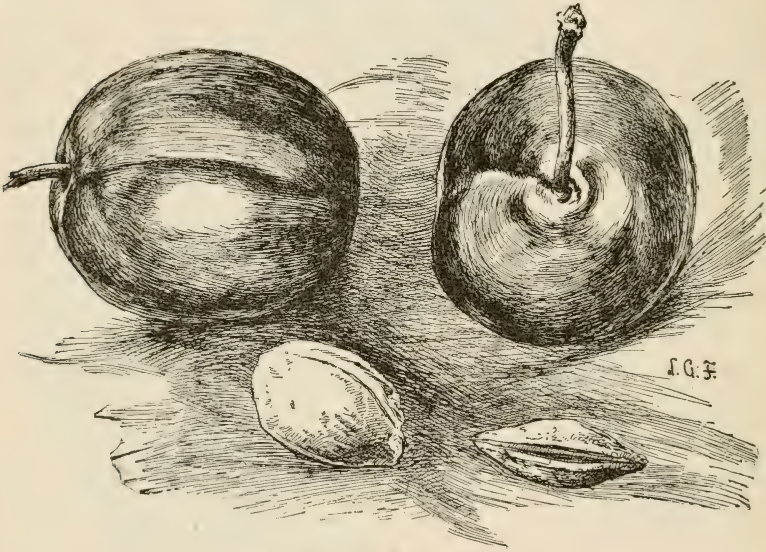
*Niagara.*—See Bradshaw.

*Orange Prune.*—A variety originating, I think, in Orange County of this State and highly commended at one time, but of no value whatever as

grown in my orchard. Trees have been grafted over. In size, color and quality an absolute failure.

*Oswego.*—Origin, Oswego, N. Y., and said to be a seedling, but so strongly resembling Pond's Seedling, or Fonthill, that I am inclined to regard them as identical.

*Peter's Yellow Gage* (Fig. 45.).—Origin unknown. Fruit medium to large; nearly globular; pale yellow, sometimes little shaded red in the sun; flesh yellowish, very rich and juicy; ripening about middle of August. Tree hardy in wood and bud, an excellent variety in a family collection. An old plum of great excellence. [Fruit generally globular-oblong, with a deep suture and light bloom; color of Reine Claude.—L. H. B.]



45.—*Peter's Yellow Gage.*

**Pond.*—(Pond's Seedling, Hungarian Prune.).—Fruit oval; bright red; enormously large when well matured. Productive and tree very hardy; much inclined to rot before mature and rather inferior in quality. It cannot be denominated a favorite orchard sort in western New York.

* *Prince Englebert.*—Fruit large; oval; deep purple, with a dense bloom; rich and excellent in quality; free-stone; profuse bearer. The tree is clothed with a perfect foliage and is very hardy. But little known, and at least deserving a place in every private collection. Its period of ripening about the last of August, is hardly in its favor as a very desirable market sort. Said to have originated in Belgium.

* *Prince of Wales.*—Fruit round; reddish purple; medium size; ripening about Sept. 1st, and has much to commend it to general favor. Were it a

little later in maturing its crop, might become a favorite market sort. Tree very hardy ; a great bearer.

*Prune D'Agen.*—Fruit medium size ; oval ; excellent in quality ; skin violet-purple. Productive, but as a market sort not equal to either the Italian or German prunes and tree more indifferent as a grower. My own experience inclines me to advise top-working all prunes on strong growing sorts like Lombard, believing that the most satisfactory result will be attained to the orchardist by this method.

*Prunus Simonii.*—A fruit that has been sold by thousands throughout the country and for which there continues yet to be a slight demand, and yet too poor in quality to have any value whatever, and unworthy of even a description.

*Quackenboss* (Fig. 40, II.).—Fruit large ; rather oblong ; deep purple, covered with a fine bloom ; flesh yellow ; quality only fair, but by reason of its large size and attractive appearance sells well upon the markets. Ripens early in September. Tree very hardy, with spreading habit, slow in coming into bearing and has never been sufficiently productive on my grounds. Originated in eastern New York.

*Reagles' Union Purple.*—Originated near Schenectady, New York. Fruit large ; roundish ; skin red to light purple ; good quality, fine to eat from the hand, but flesh too tender for marketing and of no value for this purpose. The tree very hardy, very few plums equalling it in this respect. Have used a large number of trees in orchard for grafting other sorts upon. An old variety now rarely grown.

*Reine Claude de Bavay.*—Skin greenish yellow ; flesh yellow, juicy and melting. Probably the most productive and valuable of the yellow plums. Tree vigorous, but inclined to overbear, and somewhat tender. It begins to produce very early from planting and if well cared for will set an annual crop. The most enduring and reliable trees I have are those top-worked on stock of more hardy sorts. [Fruit of medium size, nearly globular, dull yellow with green shadings or markings, and a thin bloom; late. Tree is likely to be short-lived, the first evidences of failure usually showing in the dying of the bark upon the trunk. It can no doubt be improved in vigor and longevity by top-working it upon strong stocks. In the books often known as Bavay, but cultivated under the name of Reine Claude.—L. H. B.]

*Richland.*—Origin, Bucks County, Pa. Roundish ; skin reddish purple ; flesh yellow ; quality fair. Ripening last of August, but of no value for commercial purposes in competition with others that are so much superior to it. Tree hardy and productive. The trees we have had have been grafted over.

*Rood.*—See Empire.

*Shipper's Pride* (Fig. 42).—Origin, Cayuga County, New York. Fruit of fair size for shipping ; skin dark purple, inclined to be green or to ripen unevenly in the shade. Not sufficiently attractive to commend it as a market sort and ripening last of August with a multitude of others of more value.

Tree hardy, vigorous and fairly productive. We have worked over our trees to what we regard as better sorts. [Strongly resembles Empire. Shipper's Pride is the earlier by two or three days, bluer, more pointed, with a longer stem, stone wholly free whilst in Empire it is cling. Quality only fair. See Figs. 41 and 42.—L. H. B.]

* *Shropshire Damson* (Fig. 46).—Dark purple ; rather obovate, a little larger than ordinary Blue Damson ; very productive. It ripens from last of August to early in September and can be profitably grown in the orchard. Like many others of the English sort, however, it is inclined to drop its foliage early.

*Smith's Orleans.*—Largely grown twenty-five yea s since and then regarded as a valuable sort for the family garden, but its period of ripening,—little past middle of August,—has rendered it unpopular in the commercial orchard list, hence it is but rarely found in the nurseries of to-day.

46.—*Shropshire Damson. Two-thirds full size.*

Fruit large ; flesh yellow, juicy and rich ; skin reddish purple ; excellent for eating.

*Spaulding.*—Medium size ; yellowish green ; quality fair. Moderately productive and ripening a little earlier than Reine Claude. Has nothing of especial value to commend it to the commercial orchardist. This variety was put upon the market as curculio-proof, which, of course, it is not.

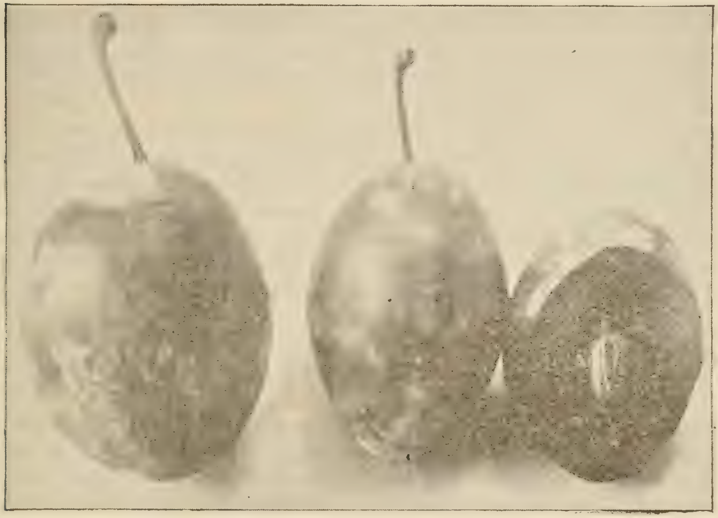
*Stanton.*—Origin, Albany Co., New York. Fruit medium size ; nearly round ; excellent in quality either for eating from the hand or preserving. Ripening middle of September, often later, and having the property of keeping well after being picked. It is an excellent shipper, but unless picked before too mature is inclined to drop from the tree. It is a little

tardy in coming into bearing, but can be regarded as a desirable orchard variety.

*Union Purple.*—See Reagles' Union Purple.

* *Victoria.*—Fruit large; oval; reddish upon a yellow ground. An abundant bearer, but foliage very defective, frequently leaving the tree with a mass of unripened fruit, which, in a warm, moist season, is apt to decay badly. With me this variety has been a complete failure.

*Warner's Late Red.*—A late, small, red plum sent to me several years since from Schoharie County, N. Y. Tree very hardy and prolific, but fruit lacking in such essentials as would be regarded desirable either for home use or market.



47.—*Weedsport Prune.*

*Washington.*—One of the largest of all plums, of fine quality, skin yellow; has an excellent foliage. Fruit ripens middle to last of August at Geneva. Tree vigorous and hardy, desirable in a family collection, but can hardly be said to have value as a market fruit.

*Weedsport Prune* (Fig. 47).—One of the many German prunes, the tree of which is so poor a grower that it will be grown by few in the nursery, and the fruit differs little from several other strains. Much esteemed about Weedsport, N. Y.

*Yellow Egg.*—A variety that has been disseminated under several other names, but more frequently called for as Magnum Bonum. Very popular because of its beauty and size and value for canning purposes. Skin yellow with a bloom and a deep golden color when fully mature. The tree is on

of the most hardy of the plum family and where this is an essential, it should be more generally planted, provided the soil is inclined to be heavy. On some of the light soils of Michigan we have known of its dropping the fruit badly before mature. Its large size and fine qualities for canning make a demand for this purpose among those engaged in this industry which would warrant its cultivation more largely. It ripens about the middle of August, is of low quality and in no sense a desirable fruit to eat from the hand.

*Yellow Gage* is a general name for a class of yellow plums, of which Peter's Yellow Gage is the best for western New York.

## *Japanese Plums.*

*Abundance.*—A variety of the Japanese plum which I have now been fruiting for eight or nine years. I regard it as one of the best of several of the family that I have tested and so well known as to need no description. Quality good and productive; tree hardy and vigorous, but in no sense equal in my estimation to the next.

*Burbank.*—A variety sent out by Mr. Luther Burbank, of Santa Rosa, California, and well described in Bulletin 106 of the Cornell Experiment Station. The tree is very hardy and vigorous, but the most sprawling in its habits of growth of any plum I have ever cultivated. As regards productiveness, it is unequaled by any plum I have ever fruited. To produce the finest fruit heavy thinning should be practiced. The quality is excellent and it is destined to become one of the most popular of all plums for canning, while its attractive color, good quality and shipping properties will cause it to be sought for as a market variety. It ripens ten days to two weeks later than Abundance. I have had it in fine condition the last week in August and early in September.

*Kelsey.*—This variety has winter-killed to such an extent that I abandoned any effort to fruit it and am sure if the variety obtained was true to name that it cannot be grown as an orchard tree at this place. [We still hear of the Kelsey being fruited in New York, but in every case which we have investigated some other Japanese variety has been misnamed the Kelsey. The farthest north which I have ever known the true Kelsey to fruit is southern Delaware.—L. H. B.]

*Ogon.*—Medium to large; color lemon yellow; flesh firm and a good shipper; perfect free-stone; quality poor; inclined to drop badly before mature, and is only a fair producer. I see no reason why it should be planted in the commercial orchard, but is a good canner. Have had it in fruit for several years.

*True Sweet Botan.*—Received from J. C. Normand, of Marksville, Louisiana. It closely resembles the Abundance in wood and fruit, and yet it seems inclined to ripen a few days earlier; of better quality and apt to take on a brighter red color; hardy and productive.

*Willard.*—This variety, with several others, was obtained in a lot of cions obtained in California several years since and in which I became specially

interested because of its vigorous habit and hardiness. Size medium; color red and attractive; productive; very early; frequently ripening by 15th to 20th of July, and when picked early will keep a long time in good condition with no disposition to decay. Quality poor; indeed, as compared with others, I regard it as inferior.

*Yellow Japan.*—This variety was obtained of Mr. Normand, and I understand has also been disseminated under the name of the Chase. Fruit not quite equal to Burbank in point of size as grown in close proximity on my grounds. Color of skin not quite so dark. Quality good, habit of growth upright, foliage not so strong and in my opinion the tree might not endure as low a temperature without injury as the Burbank. It ripens considerably later and is more variable in its habits. The fruit has been much larger and of better quality and color some seasons than others, upon the same trees; hence, I have been led to infer that it is scarcely as reliable as Burbank. [This is the Chase of my Bulletin 106, and that name should be preferred.—L. H. B.].

The following is a list of others of the Japan family, growing for test purposes, some of which have borne a little fruit, but not sufficient to warrant an expression as to their merits: Satsuma, Berger, Wickson, Red June, Normand, Shiro Smomo, October Purple. The last received from Luther Burbank from whom also sample fruit was had, which was fine in appearance and of excellent quality, and should this variety develop quality and productiveness of a satisfactory nature here, I believe it will be valuable.

Bulletin 132. March, 1897.

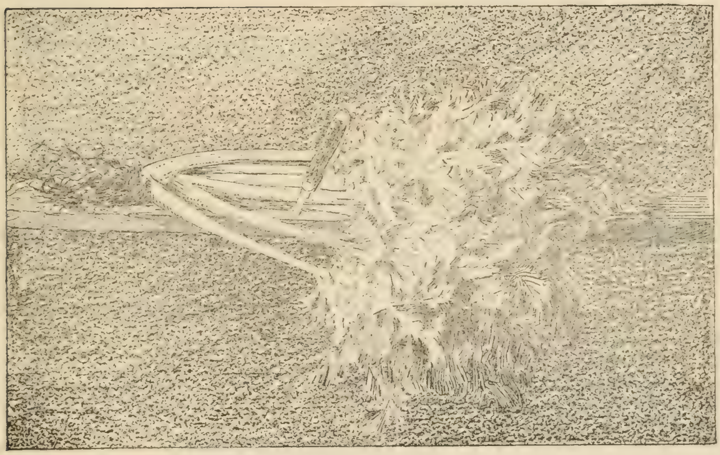
Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

Botanical and Horticultural Divisions.

# NOTES UPON CELERY.





By B. M. DUGGAR and L. H. BAILEY.

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## BULLETINS OF 1897.

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126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk About Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums for western New York.
132. Notes upon Celery.

CORNELL UNIVERSITY, ITHACA, N. Y., March 30, 1897.
HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

*Sir:* The things which celery growers in western New York chiefly want to know is what to do for blight and how to fertilize the land. We have tried to find out. The attempt is submitted for publication under Chapter 437 of the laws of 1896.

L. H. BAILEY.

## CONTENTS.

56.—*Interior view of old-style storage house, shown in Fig. 51. Celery mostly removed.*

# NOTES UPON CELERY.

## I. TWO DESTRUCTIVE CELERY BLIGHTS.

*Introductory.*

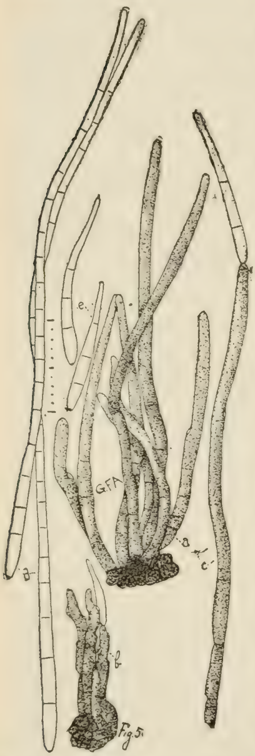
The celery industry in New York has attained a rapid development during the past ten or twelve years. It was only a few years earlier that this plant became so extensively cultivated in the favorable region about Kalamazoo, Mich. At the latter place the conditions are such as to form an environment peculiarly salubrious for celery, and the disease question appears not to have forced itself so prominently upon the attention of growers. In other widespread areas, celery is subject to several blights and spots which greatly affect the marketable value of the product. In the growth of this plant there is no little expenditure of labor, and any cause operating to reduce the price of each heart a few cents means the obliteration of the profits of the grower. There is no doubt that with favorable conditions and skillful management celery is a paying crop, but two fungous diseases, especially prevalent during the past season, threaten the profits of many. Practically, work upon these diseases has just begun, and if at the outset there is given simply a clear exposition of what these diseases are, and their effects upon the plant, it is hoped to secure the coöperation of those interested; and, in future, work will be undertaken toward definite measures of relief. In this bulletin a general knowledge of the subject will be summarized, and special attention is called to the matter of storage cellars and to the disease last season so prevalent therein.

### A. Early Blight of Celery.

*General Discussion.*

During the latter part of July of the past season, L. A. Clinton called my attention to the destructive effect of a celery disease on the truck lands of R. W. Parr, Ithaca. The plants then badly

affected were in an advanced state of growth. Many of the lower leaves were brown and wilted, while the disease seemed to spread rapidly to the younger leaves as they unfolded in freshness and vigor. The spots on the vigorous blades were characteristic of the disease popularly known as "celery blight," and a microscopic examination confirmed this, showing the causal fungus to be *Cercospora Apii*. This is one of the first celery diseases to make its appearance either in the seed-bed or in the field. It is a well known pest in Europe, and in this country it seems to have received spasmodic attention for nearly fifteen years. Beginning on the outermost green leaves, it appears in spots more or less circular, grayish-green at first, and becoming brown and ashen. In the early stages of the disease there is a well defined spot with slightly raised border; but when the spots become numerous on a leaf, the latter begins to turn yellow, and subsequently the fungus develops abundantly its fruiting growth in indefinite areas, thus giving the characteristic ashen spots of indiscriminate form. The filamentous vegetative organs of this fungus, like most parasitic fungi, grow within the tissues of the leaf, and soon minute fertile filaments, or hyphæ, are protruded in slight fascicles through the pores, or stomates, of the leaf. These fertile hyphæ (or fruiting filaments) as seen under the microscope are illustrated in Figure 48, *a*, *b*, and *c**; and here it is also seen that these hyphæ bear hyaline reproductive bodies, the spores, or conidia, *e* and *d*. Falling upon other leaves with suitable moisture, these conidia germinate by the protrusion of delicate thread-like tubes, and these tubes effect an entrance



48.—*Microscopic characters of the early blight.*

*This figure was drawn by Professor Geo. F. Atkinson, and used by him in Bulletin 49 of this Station.

through the epidermis of the leaf to the tissues within, where they spread and again cause the death of the affected parts, and consequently the characteristic spots. Each hypha bears more than a single conidium, and the scars or knees shown in the figure are the points at which successive conidia were borne. The conidia retain their vitality for some time, and it is feared that they may be able quite generally to pass the winter without injury.

Considerable confusion exists regarding the nature of the season during which this disease is most prevalent. It has been reported most abundant during the hot, dry periods, and also most injurious during the warm "muggy" days.* In my own experience heat is an important factor, but moisture does not necessarily give the celery plant the mastery. In hot dry weather the vigor of the plaut is reduced; and, with heavy dews at night, the action of the fungus is marked, especially on the lower leaves. With a wet soil and muggy days I have noted a rapid spread of the fungus, and it is then that the disease will spread over large areas of wilted or affected leaves. In a report† of the Division of Vegetable Pathology, it is stated that shade is of great importance; that where the soil is cool and moist, and the air humid, as at Kalamazoo, Mich., the disease is said to be unknown. In this connection the only observations I was able to make were upon small areas in well drained, shaded, garden lots; and in such locations the fungus was not abundant. This disease disappears with the cool nights of autumn, and it may be followed by the other blight discussed in this bulletin. Because this celery disease does not usually appear late in the season, and in order to distinguish it from others, I have spoken of it as the early blight of celery.

*Remedies.*

The use of fungicides for the prevention of the early blight has been attempted with varying success, but there is still lacking much definite information about the use of these materials which will necessitate some extended experiments during the ensuing season.

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*Report U. S. Dept. Agriculture, 1886, p. 117.

†Report U. S. Dept. Agriculture, 1888, p. 398.

Salt, lime, hyposulfite of soda, potassium sulfide, etc., have been used unsuccessfully.

Experiments conducted by the Division of Vegetable Pathology at Washington indicate that shading the plants by means of screens is most effective ; but this seems wholly impracticable.

The most pronounced results thus far with fungicides are in favor of the ammoniacal copper carbonate solution, although in one region sulfur has seemed more successful. At the New Jersey Experiment Station in 1891, Halsted found that the yield of marketable celery from a row treated with the copper compound was nearly double that of an untreated adjacent row ; and, moreover, application of the fungicide was not made until the celery was already badly blighted. At the Connecticut (New Haven) Experiment Station, Sturgis recommends the use of dry sulfur at the rate of 2 lbs. for 1,200 plants.

It is necessary to add a few experiments made in Ithaca during the past season, in the field where the early blight was first observed. As before mentioned, most of this celery was in an advanced stage of growth, and badly diseased ; but it was thought that if the fungus could be checked until lifting time, much good might result, and at least a practical demonstration of the use of fungicides for celery would have been made for the Ithaca growers. Sulfur at the rate of 1 lb. to 1,000 plants and a standard solution* of ammoniacal copper carbonate were used. An application of one of these fungicides was made to each of two plats of celery, and a larger plat untreated reserved as check, the treatment being given on July 28, an exceedingly hot day. The following week there were alternate rains and scorching suns, and at the end of this time the plants sprayed with copper carbonate appeared slightly scalded. There was then hot, dry weather for a week or more, and on August 15 there was marked improvement in the rows sprayed with the copper compound,—so much so that it might be detected at some distance. The rows dusted with sulfur showed some improvement, but less than the sprayed plat. On

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* A formula often used is as follows :

| | |
|---|---|
| Copper carbonate | 8 ozs. |
| Ammonia water (26°) | 3 pints. |
| Water | 45 gals. |

August 15 a second application was made as before, except that a weaker solution* of the copper carbonate was used. A heavy rain followed in a short time, and little result could be anticipated from this application. I was then necessarily absent from Ithaca for a month, and further applications were not made. Thus the work was left in rather indefinite shape to await earlier experimentation another season. The results at least suggest that carbonate of copper may be used to advantage. At the time of setting, young plants (leaves only) might be dipped in a weak solution of this fungicide, and subsequently the growing plants sprayed at intervals of two weeks with a solution of the same strength. Any of the spraying apparatus used for potatoes would suffice for this work. Growers should be extremely careful not to set plants which are in any way spotted in the seed bed; and if the sets are purchased, use none in a lot showing any indication of the disease.

The fact that the spores of the fungus have been found to germinate after passing the winter on the dead leaves† of the previous season will suggest to progressive growers the need of destroying all refuse matter and diseased material. Bits of diseased material will remain, however, and this alone indicates that rotation is a good thing where it is practicable. Again, the fungus spreads rapidly upon wilted plants, especially in muggy weather, so that care should be taken to collect and destroy the product of suckering. A disease of the common wild parsnip so closely resembles this celery blight that many botanists consider them forms of the same disease; so it may be well to rid the borders and fence rows of the wild parsnips.

### *Artificial Cultures of the Fungus.*

The length of the fruiting hyphae and conidia are largely dependent upon the amount of moisture in which they are developed, and probably somewhat inversely upon the vigor of the leaf. On leaves placed in a moist chamber the condition is much as represented in Figure 48, *c* and *d* (pro-

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* This formula consisted of

| | |
|---|---|
| Copper carbonate | 6 ozs. |
| Ammonia water (26°) | 2 pints. |
| Water | 45 gals. |

† Report U. S. Dept. Agriculture, 1888, p. 399.

duced on wilted leaves in a wet season) ; while $b$ and $c$ show the same fungus under normal conditions. I have experienced no difficulty in germinating the fungus on plates of agar, and in securing pure cultures in tubes of sterile bean stems or of petioles of celery. In this condition the fruiting hyphae are often ultimately more than a millimeter in length. At first conidia are regularly produced, leaving the accustomed geniculations ; and these conidia vary in length from some exceedingly short to others measuring 250 $\mu$. After the hyphae have attained considerable length no further conidia are produced ; and, instead, the spore-like branches which arise remain attached, and appear as true branches of fertile hyphae. Figure 49 (Leitz ocular 1, objective 4) illustrates the character of growth on bean stems. I neglected to make a photograph of a good petri-dish isolation culture until it was badly contaminated with bacteria ; but Fig. 50 serves to show the nature of the growth on agar. The colonies are large, circular, at first olivaceous, and not readily separable from the agar. Later a grayish-white aërial growth of cottony mycelium appears, interspersed with which are the long fruiting hyphae. In general, growth in artificial cultures is characteristic, both on agar and on bean stems, differing materially from that of half a dozen *Cercosporæ* cultivated during the past summer. No perfect stage of this fungus has been secured; but every effort is being made to ascertain if there is an intervening perfect form. As yet, I have not been able to secure cultures of *Cercosporæ* on hosts closely related to the celery.

49.—*Hyphae of the Cercospora, when grown on bean stems.*

## B. LATE BLIGHT OF CELERY.

### *General Discussion.*

At the same time that the early blight was abundant on the Ithaca flats, a different disease was found in a garden not far distant. The latter disease had then appeared on a few leaves only. In general appearance it might easily have been mistaken for the early blight, although it is distinguished from the latter by more irregular spots, which are of a tawny color. Under a hand lens, minute, black, fruit bodies, or pycnidia, could be seen on either

side of the leaf; and the operative fungus was found to be one called *Septoria Petroselini*, Var. *Apii*. The form on celery is a disease which has been known to mycologists in this country only about six years, and with favorable conditions for its spread, it has proved to be a most destructive celery disease. In the garden mentioned this fungus did not spread rapidly during the

50.—*Growth of the Cercospora in agar.*

summer, and it was not until early autumn that much harm seemed to have resulted from its action. With a slight attack the irregular spots are well defined; but with conditions more favorable for the disease the fungus may spread rapidly to the whole surface of the leaflets (illustrated in Figure 51), and even to the petioles, causing a complete wilting of affected leaves. The minute, black, fruit bodies, or pycnidia, are then abundant on

all parts of the leaf, and by careful observation they may be seen with the naked eye.

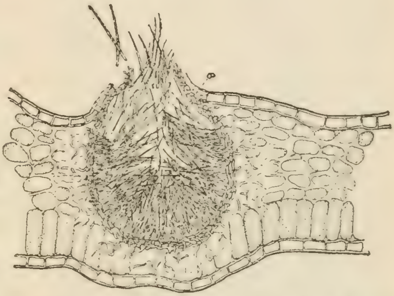
A section of a leaf through one of these minute pycnidia is shown in Figure 52. At *a* is shown a cross section of the more or less spherical fruit body. It is deeply immersed in the tissues of the leaf, and the walls are stout and appressed. From these walls arise a forest-like mass of minute filaments, or basidia,

51—*Spots of late blight on a celery leaf.*

bearing the needle-shaped spores, or reproductive bodies of the fungus. When ripe, these spores are doubtless expelled through the mouth of the pycnidium by means of absorbed water, and then they are readily scattered by wind and rain for the immediate dissemination of the fungus. The spores readily germinate, giving rise to the delicate tube-like filaments, which enter the tissues of the leaf as mentioned for the *Cercospora*.

The disease is active in the field until the last plants are lifted; and, as mentioned before, I have found it following the early blight during the cooler weather. However, as will be seen later, the late blight does not confine its ravages to the field, but extends its destructive action to the storage coop, or cellar, and as the disease has already been termed a blight, it seems well to speak of it as the "late blight." There is already another fungus called the "leaf-spot of celery."

From later observations it seems that the late blight was the most injurious celery fungus during the past season, but it was not so destructive at Ithaca. Few experiments have as yet been made with the use of fungicides upon it, but it has been recommended by the New York (State) Station at Geneva to spray young plants with Bordeaux mixture. With older plants it would be better to use the ammoniacal copper carbonate, or it may prove as well to use the latter throughout. The same caution relative to the use of healthy seedlings will apply as for the early blight, and in this case it is especially necessary to begin early. Further remedial suggestions will be made later.



52.—*Section of a pycnidium, or fruit-body, of the late blight.*

### *Late Blight in the Storage House.*

It is to be remembered that the late blight may yet be active when the last lot of celery is transferred to the coop, or root house, as these storage cellars are variously termed. This brings us to an important feature of the celery disease question, and one which, apparently, has hitherto received no attention. Again my attention was first called to this matter on the premises of R. W. Parr, Ithaca, by an examination made late in December of celery stored both in a cellar and in a root house. In the cellar where the trouble was greatest, the temperature was manifestly higher than might be desired. The first effect of the disease is quite the same

as that seen in the garden in severe cases. The outer green leaves are the first to wilt, and on these the black dots, representing the fruiting bodies of the fungus, are scattered indiscriminately. Soon the fungus spreads to the younger and blanching central leaves, wilting and discoloring these wherever a foothold is secured. Fig. 53 is a photograph of a diseased plant from this cellar, showing the wilted and blackened appearance of the leaves. The plant was so much wilted that the photograph was necessarily taken by suspending the plant top downward. In the root house the temperature was evidently much lower than in the cellar, but even in the former the disease was destructive. As far as marketable plants were concerned, the whole stored product was greatly reduced, and I could see no hope of profit on the necessary outlay.

53.—*Celery plant, from a cellar, affected with late blight.*

As the late blight was proving so destructive in Ithaca, where celery is grown on a small scale only, it was thought well to visit some other truck regions of the state where celery gardens are more abundant. Accordingly, early in January a visit was made to South Lima and Irondequoit with the hope of securing, even at this late date, additional and valuable data relative to the injuries from this disease in the storage cellar.

On making a survey of the root houses at South Lima, I found the amount of loss sustained from the late blight far greater than

had been anticipated. A large portion of the stored product had been marketed early on account of the prevalence of the disease; and of the celery remaining in the coops at this season, it seems to me a fair estimate to say that not more than one-third of it was salable. The celery growers of this place reported that they were not familiar with the blight in previous years, and during the past season it first came to their attention during September, when the plants were lifted for storage. At this time the leaves were somewhat spotted by the disease. This was evident on examining the older and formerly green leaves of the stored product; for the tell-tale spots, produced only when the celery is in a normal growing condition, were abundantly manifest. It was supposed by the growers that the warm weather following the first early cold spell had much to do with the trouble. As a matter of fact, there was much warm weather after most of the celery had been removed to the cellar. From the state meteorological records it will be seen that the month of September was one degree colder than normal, October two and one-half degree below the normal, and for November the temperature was nearly five degrees (4.7°) warmer than the normal temperature as thus far determined. This rise of temperature was undoubtedly a serious thing, for warmth is an important factor in encouraging the spread of the fungus. The celery plants being arranged close together in the root house, the fungus spreads not only, it may be, from its former circumscribed spot areas to all parts of the leaf, but to neighboring more healthy leaves; so that on the surface there is a dense stratum of the diseased material, and as the young blanched leaves push upward they in turn come in direct contact with the germs of disease. When once decay begins, bacteria, yeasts, and moulds readily effect rapid rotting of parts not easily affected by the blight itself. This was especially true where moisture was greatest. It is only to be regretted that we did not know earlier of the prevalence of the blight in the storage houses; for its effects might then have been closely followed, and a knowledge of the exact conditions which accelerate the destructiveness of the disease could now be more accurately applied.

Nearly all of the root houses of South Lima are of the old style,—essentially a roof of boards upon which is thrown straw,

earth and manure, as represented in Fig. 56; but a brief discussion of specific styles of root houses will be considered later.

At Irondequoit, near Rochester, there are located some of the largest celery gardens of the state. At this place I found the condition of the celery a great improvement over that at South Lima. Nevertheless, considerable loss had resulted, and I was confirmed in the belief that the late blight was generally quite prevalent in the field during the past season. Here the disease had extended to the storage house product to an injurious extent, but there was evidently some important factor to account for its lessened effect. At Irondequoit there is a well drained gravelly soil, with clay subsoil, and it was noticeable that in the root-houses of this region there was much less moisture than in those of South Lima. It was this difference, in fact, which readily suggested that care should be taken with regard to the location of coops, especially for the contingency of unfavorable seasons.

Why the South Lima root houses contain more moisture, and hence were more severely visited, it is necessary to consider the surroundings. It is only within the past few years that celery has been grown to any extent in this region. Previous to this time there were about six hundred or more acres of bog land north and south of the Erie Railroad, which could have been purchased for almost nothing. Drainage of this area was since authorized, and it is this drained bog land which is now so valuable for the growth of celery. It is a true peaty soil, which burns very readily. This deposit is said to vary to about twenty feet or more in depth, and it is underlaid by a slight gravelly deposit, and then an impervious clay. Surrounded by high land on nearly all sides, this bog land lies as a natural basin in a glaciated region. Water seems to drain freely into this gravelly substratum and it is prevented from sinking further on account of the impervious clay. The peaty stratum above absorbs the water freely, and on account of its great capillary action it is capable of constantly pumping up the water from below, thus furnishing a soil in which celery grows luxuriantly. On account of this moisture, however, extra attention should be given to the disease question. With root houses located immediately upon such bog land, or upon slightly higher ground of approximately the same texture,

moisture is constantly pumped into the root house; and the necessarily inferior ventilation of such houses render them peculiarly favorable for the growth of the fungus, provided the temperature is sufficiently high. Good ventilation seems to be an important preventive factor, and the best evidence of this is afforded by the observation that the blight is less injurious along the central gangways of the cellars. On the basis of the location, however, it seems possible easily to account for the drier houses and better stored celery at Irondequoit; but it must be remembered that the past season was unfavorable everywhere. The celery which remained in the field longest was least subject to the abnormal conditions, and consequently less affected by the disease.

I also visited the celery gardens of Horseheads, near Elmira, where considerable loss had been reported. There the trench or banking system is still in vogue, and on account of the freezing weather, I could see but little of the stored product; yet those who attempted the trench system at Irondequoit during the past season were very unsuccessful, and on the whole it seems unwise to recommend it for protracted storage.

### *Remedies.*

Although it has not yet been possible to conduct any remedial experiments, certain practical remedies are readily suggested by the conditions. A great desideratum is to bring to the root house a minimum amount of the disease. To this end, plants in the field should be sprayed regularly to prevent its appearance there. Any badly affected leaves should be stripped away before consigning to the coop, and it seems highly probable that fungicides may be used most effectively with the stored product. Without a great amount of extra labor, the leafy portion of the plants could be dipped in a weak solution of the ammoniacal copper carbonate before being stored, and as there is then no chance of its being washed off by rain, this measure should prove effective. The carbonate solution is mentioned because the only objection that might be urged against it is the slight deposit of copper. However, as most of the original green leaves are stripped off in the

trimmings, and as the plants are subsequently thoroughly washed, it seems that this efficient fungicide might be used without encountering the enmity of the most fastidious purchaser.

As previously mentioned, it is not known how the fungus causing this disease passes the winter, but it is quite likely that all diseased leaves and culls, both from the field and root house, are certain sources of contamination another year. It is doubtless impossible to destroy all such diseased material, but the more that is destroyed the less the probability of abundant reappearance; and if the disease is to be fought effectively, it must be fought in every stage.

### *Special Characters of the Fungus, and Artificial Cultures.*

According to Halsted* the first mention of a *Septoria* on celery is by Briosi and Cavara†, in 1890. Here the fungus is given under the name mentioned above (*Septoria Petroselini* Desm., Var. *Apii* B. & C.)‡. By Halsted, Chester, and Ellis this fungus has been compared with the species distributed by Briosi and Cavara, and they see no reason why our American form is not the same. There seems to be some doubt regarding the character of the spores. Halsted figures them uniformly septate, while Chester apparently saw no septa, and he describes them as "apparently non-septate, or septulate, guttulate." I have carefully examined a number of specimens from the field and from artificial cultures. Invariably mature spores are septate; but often the septa are not visible without the use of stains.

The spores germinate readily in agar, so that isolation cultures may be made in petri dishes. From such cultures, transfers to tubes of sterile bean stems have given good growths of the organism in a pure form. These cultures have given mature pycnidia in a few weeks. The perithecia are then formed superficially upon the bean stems, and formed of loosely woven, brown hyphae. Humphrey§ has suggested that the *Septoria* is connected with the *Cercospora* as pleomorphic forms of the same species. His suggestions, I believe, are based mainly upon gradations in spot characters. Chester was never able to find both fungi in the same spot, although both were sometimes found upon the same leaf. My cultures indicate as clearly as possible thus far that these two fungi have no genetic connection, if we may judge at all from growth characters. Under similar conditions, not only has the

* Report, New Jersey Ag'l. Exp. Sta., 1891, p. 256.

† Funghi Parasitti Fascecola, VI. No. 144

‡ *Note.* The only additional foreign mention yet encountered of a celery disease due to a *Septoria* is a short article by Sorauer on "Die Fleckenkrankheit des Sellerie," in Zeitschrift für Pflanzenkrankheiten, VI. (1896), H. 3, p. 191. The spores of this *Septoria* are described as non-vacuolate, non-septate.

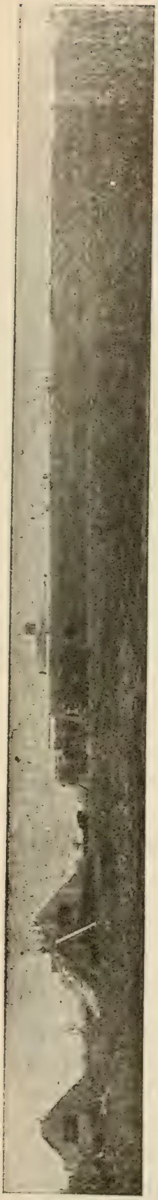
§ Report Mass. Agl. Exp. Sta., 1891, p. 231.

*Cercospora* produced only *Cercospora*, and the *Septoria* only *Septoria*, but the general character of the mycelium both in petri dishes and on bean stems is essentially distinct. Either or both of these fungi may have a perfect form, and these I am attempting to encourage; but I think it unnecessary to hold that the two fungi will be found to have the same perfect form. Should it be so, this fact would be of importance relative to the appearance of the disease in the root houses or storage cellars.

54.—*View of celery houses at South Lima.*

## C. REMARKS ABOUT THE CONSTRUCTION OF STORAGE HOUSES.

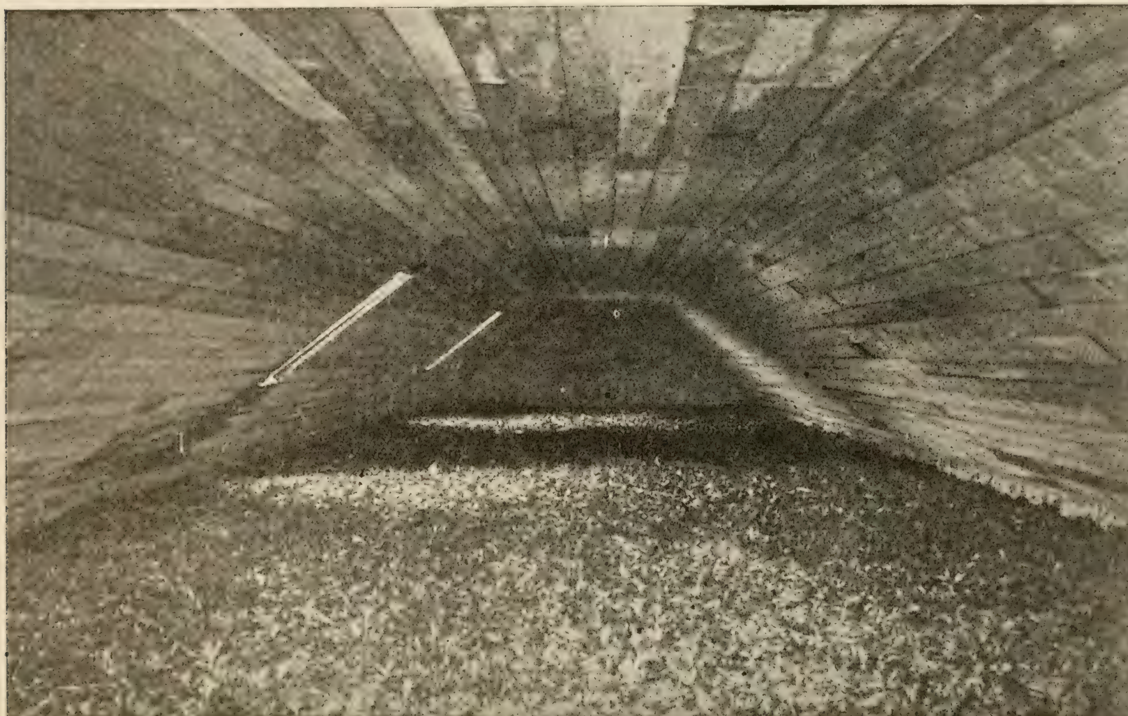
The growing demand for celery during the late winter months has recently brought about considerable improvement in the construction of storage houses; and as has been suggested, this matter is intimately associated with the disease question. The original type of root house, which I have not seen in New York, was essentially a rail coop. Upon the rails, straw and earth, or manure, were placed in sufficient quantity to keep out cold and moisture. Trade demands soon necessitated the form seen in Figs. 54, 55, 56, for the storage of celery. This form is well known, and the construction of this is easily made out with the aid of Fig. 56, which is an interior view. These houses are usually provided with double doors at both ends, two or more



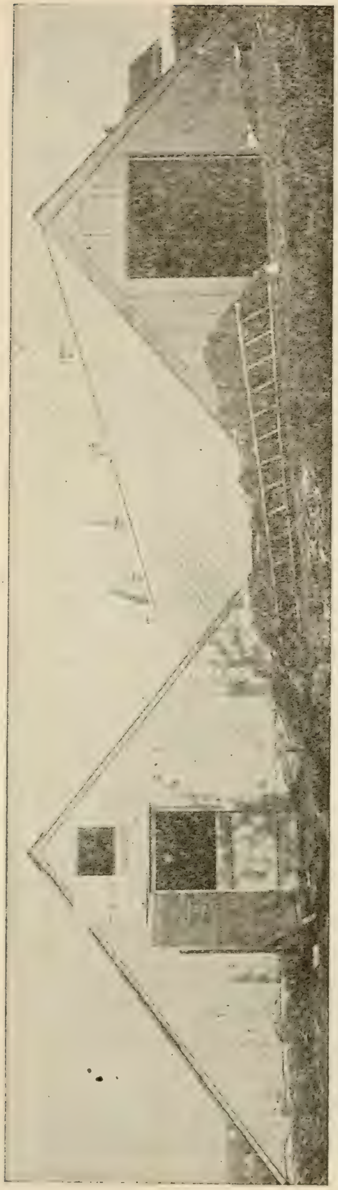
55.—*South view of the earth-covered houses of South Lima.*

windows, and with a number of ventilators. The greatest difficulty with these houses is that they rot down rapidly, and they may give some trouble with moisture. They are inexpensive, however, and the cost of construction is only about $125. It may be suggested that in constructing root houses or storage houses of any kind the fundamental principles involved relative to the purpose of the structure should be constantly considered. To continue its vitality, succulence, and crispness, celery must continue in the storage house a very slow growth,—a growth sufficient to establish the roots in the soil and to complete the development of the inner leaves. Thorough freezing is fatal, but the lowest temperature at which freezing will not take place is most desirable. Not only does this temperature hold the plant in the desired condition of greatly suspended activities, but it renders next to impossible the growth of injurious fungi which would speedily wilt and rot it. In order, then, to approach the temperature sought, the house should be so snugly constructed as to provide against freezing. Again, it should be so provided with ventilating appliances that at any time advantage might be taken of any cold intervals to rapidly and effectually chill the house, after which it might be securely closed for a warmer period; and with this enclosed lower temperature remain for a time at a point more nearly that desired.

In Figs. 57 and 58 is shown one of the most improved root houses which I have seen in operation, and the photograph here reproduced was taken on the premises of Abram Franke, Irondequoit. With the usual excavation of eighteen inches or two feet, this structure has a brick foundation, and the roof is well provided



58.—*Interior view of one of the houses shown in Fig. 57.* *See page 216.*



57.—*Improved celery houses at Irondequoit.*

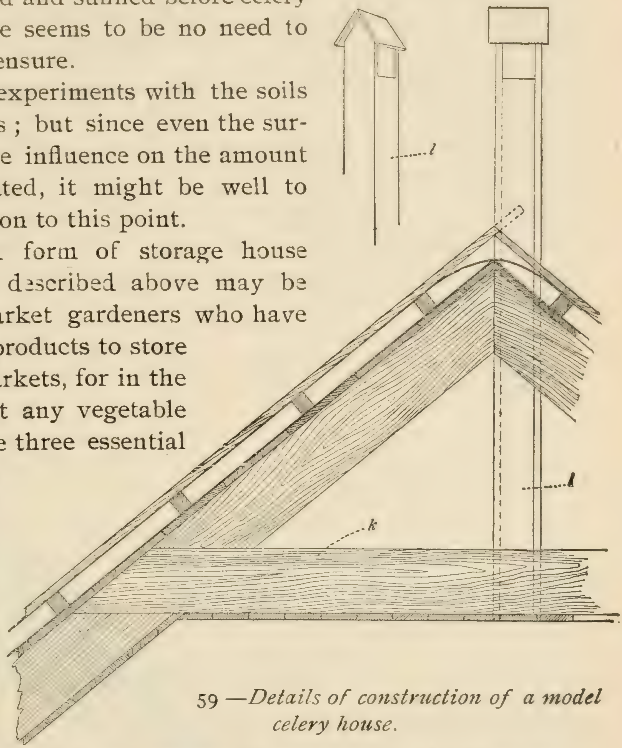
with air chambers and paper linings, affording the best protection against cold. The additional large air chamber above the collar beams, with its separate windows, seems also desirable. There are large double doors at each end, and the space between each outer and inner door is large, and the connections well arranged for the exclusion of cold air. It seems of sufficient interest to give a view of such a storage house; but full details of construction may not be entered upon in this connection. It will be seen that Fig. 59 shows the construction of the peak and collar-beam (k) of the house, and also of the ventilator (l, l). Fig. 60 shows the detail of the roof construction. The plate (h) is held firmly to the wall by a tongue (i) let into the brick work. The rafter is b. On this is a thickness of sheathing upon either side (a, c), with an air-space at e, and outer sheathing at g, and building paper at d and f. The cost of labor and materials is about $500. An interior view of this house is shown in Fig. 58 (page 200). It was stocked with celery at the time this photograph was taken, and in

spite of having been harvested early, the plants were fairing well.

I have seen a cheaper and modified form of the above structure provided with a single air chamber outside of the rafters and first boarding, with tarred paper covering the final layer of boards. The odor of tar in the house has caused comment ; but if the house is well aired and sunned before celery is admitted, there seems to be no need to fear even local censure.

I know of no experiments with the soils of storage houses ; but since even the surface soil has some influence on the amount of water evaporated, it might be well to give some attention to this point.

The improved form of storage house which has been described above may be suggestive to market gardeners who have other vegetable products to store for the winter markets, for in the storage of almost any vegetable product the same three essential features are to be borne in mind, viz.: (1) protection against freezing ; (2) a temperature so low that the activities of the plant may not be incited and that the growth of fungi may be discouraged; and (3) proper protection against excessive moisture.




59 —*Details of construction of a model celery house.*

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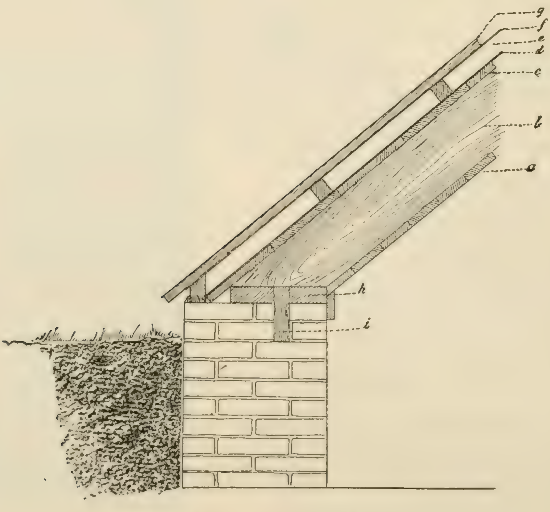
B. M. DUGGAR.




60.—*Details of construction.*

## II. EXPERIMENTS WITH FERTILIZERS ON CELERY.

Upon the 26th of June, 1896, an experiment in fertilizing celery was laid out near Rome, New York, upon the premises of B. F. Richardson. The area was flat muck land, of half wild meadow, broken up that year. It had never grown celery and had never received fertilizers.

The rows of celery were 28 rods long and 4 feet apart. Each row, therefore, represents about one-twenty-fourth of an acre of land. The plants of Golden Self-Blanching were set from four to six inches apart in the row, and the other varieties from six to eight inches. The fertilizer was carefully strewn by hand in a little furrow made upon either side of the row, after the plants were established in the soil, and it was then covered with earth. Care was exercised to keep the material from coming nearer than two or three inches to the plants. The season turned out to be very dry, and therefore the crop was less than it should have been. However, it was given excellent care, and there were marked differences in the plots when final notes were taken on the 31st of October. The celery was bleached by banking with earth.

The samples shown in the illustrations were taken by selecting six average plants from near the end of each row. The weights of these six average plants are entered in the records below. Chemical analyses were made from these samples, as displayed on page 229. The photographs showing the samples are all taken to the same scale. The weights of all the plants in each plot were also taken, but are not reported here.

VIII. Seven rows Golden Self-Blanching celery, set June 20. Received July 17, 100 lbs., high-grade sulfate of potash, 14 lbs. to the row.

Crop rather poor. Fig. 61.

Six plants, 4 lbs., 1 oz.

IX. Seven rows Golden Self-Blanching, set June 20. Received July 17, 100 lbs., high-grade muriate of potash.

Crop very much better than in plot VIII., the stalks being much thicker, broader and stronger. The difference was such as to impress any observer. Figs. 61, 63.

Six plants, 5 lbs., 14 ozs.


61.—*Two left-hand plants (VIII.) are from sulfate of potash rows, and the right-hand ones (IX.) from muriate of potash rows.*


62.—*Plants 1 and 3 from no fertilizer row; plants 2 and 4 from wood ashes rows.*


64.—*South Carolina rock, one bunch of six plants (XII.), and bone black, one bunch of six plants (XIV.).*


65.—*One bunch, six plants, sulfate of potash (XV.), and one bunch, six plants, check (XVI.). Notice the small stalks in the latter.*

X. One row Golden Self-Blanching, set June 20. No fertilizer.

Crop almost worthless. Figs. 62, 63.

Six plants, 2 lbs., 9 ozs.

XI. Three rows Golden Self-Blanching, set June 20. Received 200 lbs. wood ashes July 17. (The ashes analyzed 6.32 per cent potash, and 1.87 per cent phosphoric acid.)

Crop the best in the entire plantation, the stalks being numerous and very stocky and solid. Figs. 62 and 63.

Six plants, 7 lbs., 7 ozs.

XII. Five rows Kalamazoo Broad-Ribbed, set June 24. Received July 18, 100 lbs. dissolved South Carolina rock.

Crop medium to poor, the stalks being too slender. Fig. 64.

Six plants, 5 lbs. 2 ozs.

XIII. One row Kalamazoo Broad-Ribbed, set June 24. No fertilizer.

Crop unusually good for a check, being nearly equal to XII., but the row stood near a dead furrow and no doubt received some benefit from deeper plowing at that point.

XIV. Five rows Kalamazoo Broad-Ribbed, set June 24. Received July 18, 100 lbs. bone black.

Crop much better than XII., the plants being much thicker and heavier. Fig. 64.

Six plants, 6 lbs.

XV. Six rows White Plume, set June 25. Received July 18, 100 lbs. sulfate of potash.

Crop fair. Fig. 65.

Six plants, 5 lbs., 12 ozs.

One row in this plot (shown in Fig. 66) was almost ruined by being burned by the sulfate, the material having been scattered directly upon the row and much of it striking the plants.

XVI. One row White Plume, set June 25. No fertilizer.

Crop poor, stalks many but small. Fig. 65.

Six plants, 5 lbs. 15 ozs.

XVII. Six rows White Plume, set June 25. Received July 18, 200 lbs. sulfate of potash.

Crop heavy, with much broader and heavier plants than in XV.

XVIII. One row Golden Self-Blanching, set July 8. Received July 28, 10 lbs. nitrate of soda.

Crop poor, the stalks being stocky but very sort. Fig. 67.

Six plants, 2 lbs. 14 ozs.

XIX. Two rows Golden Self-Blanching, set July 8. No fertilizer.

Crop worthless. Fig. 67.

Six plants, 1 lb. 8 ozs.

XX. Seven rows Golden Self-Blanching, set July 21. Received July 28, 25 lbs. nitrate of soda, 75 lbs. dissolved South Carolina rock, 100 lbs. sulfate of potash.

Crop fair. Fig. 67.

Six plants, 4 lbs. 6 ozs.

XXI. Two rows Golden Self-Blanching, set July 21. No fertilizer.

Crop worthless.

XXII. Seven rows Golden Self-Blanching, set July 22. Received July 28, 50 lbs. nitrate of soda, 100 lbs. dissolved South Carolina rock, 200 lbs. sulfate of potash.

Crop late because of late setting, but Mr. Richardson regarded it as the best lot on the plantation considering the chance it had.

All these records show that wood-ashes gave the best results, although a combination of nitrate of soda, South Carolina rock and sulfate of potash (plot XXII.) promises to do well. Muriate of potash excelled the sulfate. Nitrate of soda alone gave poor returns. The check (no fertilizer) plots were not worth the growing.

It should be said that although this test was made with much pains, no generalizations should be drawn from it. The subject needs to be studied a number of years and in more detail before definite conclusions can be drawn. This paper is meant as a report of progress, and to call the attention of those who are experimenting with celery fertilizers to our desire to obtain more specific information. We shall endeavor to make similar experiments the coming season. It will be observed, however, that the results upon these plots were as emphatic as could have been wished.

The chemist was asked to help interpret the results, and his analyses of a plant from each plot, and of the soil, are given below.


63.—*Celery field, showing muriate of potash rows at* a, *the no fertilizer row at* b (*notice how narrow and small the row is*), *and the wood ashes rows at* c.

66.—*Sulfate of potash plot, showing one row burned by the application of the potash on the plants.*

The report of George W. Cavanaugh, assistant chemist to the Experiment Station, is as follows :

"The four principal fertilizing elements nitrogen (N), phosphoric acid ($P_2O_5$), potash ($K_2O$) and lime ($CaO$) were determined in the dry substance of the celery plant, roots excluded.

"In samples XVIII. and XX., nitrates were found in appreciable quantities. Potash seems to be the most variable ingredient ranging from 4.63 per cent to 1.97 per cent.

"Whenever potash was used in the fertilizers it is found in


67.—*Bunches of six plants of each of three lots: XVIII., nitrate of soda; XIX., no fertilizer; XX., nitrate of soda, S. Car. rock, sulfate of potash.*

greater amount in the plant than in those plants not so fertilized, except in case of No. XVI., which for some unknown reason ranks highest.

"In sample XVIII. there seems to be evidence of a partial replacement of potash by soda.

"The same result seems to follow from a comparison of samples VIII. and XX. In the former when sulfate of potash was used

alone 4.40 per cent. was found in the plant as against 2.84 per cent where nitrate of soda was used with the potash. Phosphoric acid and lime seem to be quite constant.

"While no conclusive result can be drawn from this one set of analyses it seems probable that nitrogen and potash are the plant-foods most required."

ANALYSES OF CELERY PLANTS.

| Plots. | Nitrogen per cent. | Phosphoric acid per cent. | Potash per cent. | Lime per cent. |
|---|---|---|---|---|
| VIII. $K_2SO_4$ ...... | 4.24 | .72 | 4.40 | .51 |
| IX. K Cl.......... | 3.44 | .78 | 4.48 | .40 |
| X. None........... | 4.08 | .67 | 2.96 | .43 |
| XI. Ashes ......... | 3.64 | .90 | 3.26 | .41 |
| XII. $P_2O_5$......... | 4.17 | .86 | 2.46 | .36 |
| XIV. $P_2O_5$........ | 3.77 | .93 | 2.48 | .38 |
| XVI. None........ | 4.47 | .89 | 4.63 | .49 |
| XVIII. $NaNO_3$... | 4.81 | .70 | 1.97 | .41 |
| XIX. None........ | 4.55 | .79 | 2.80 | .50 |
| XX. $NaNO_3$..... $K_2SO_4$ ... $P_2O_5$....... | 4.46 | .84 | 2.84 | .42 |

It is apparent that these figures throw little light upon the reasons for our curious results,—the high yield with potash and the very small yields with nitrogen. It was then decided to make an analysis of the soil, to find if its composition could aid in interpreting the results of the experiment. The soil was found to show no acidity. Mr. Cavanaugh found a very high content of nitrogen, phosphoric acid and potash. It was then suggested that the potash, whilst large in amount, might be unavailable. Accordingly, the potash and phosphoric acid were tested for availability, when it was found that the potash was practically all unavailable whilst the phosphoric acid was in a very available condition (as determined by digesting in a one-half per cent of hydrochloric acid for 5 hours at 40°c). Mr. Cavanaugh's figures are as follows :

### ANALYSIS OF CELERY MUCK, CALCULATED TO DRY SUBSTANCE.

| | | | *Availability.* |
|---|---|---|---|
| Nitrogen | 1.87 | per cent. | |
| Phosphoric acid | .50 | " | .065 |
| Potash | .54 | " | merest trace |
| Lime | 2.20 | " | |
| Humus | 29.29 | " | |

The unavailability of the potash seems to explain the excellent results which were obtained from the wood ashes. The chemist now suggests the use of caustic lime upon the land, in the place of fertilizers, in order to determine if the potash may be made available. It is expected that experiments will be continued along this interesting line this year.

L. H. BAILEY.

**Bulletin 133.** **April, 1897.**

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

THE

# Army-worm

IN NEW YORK.

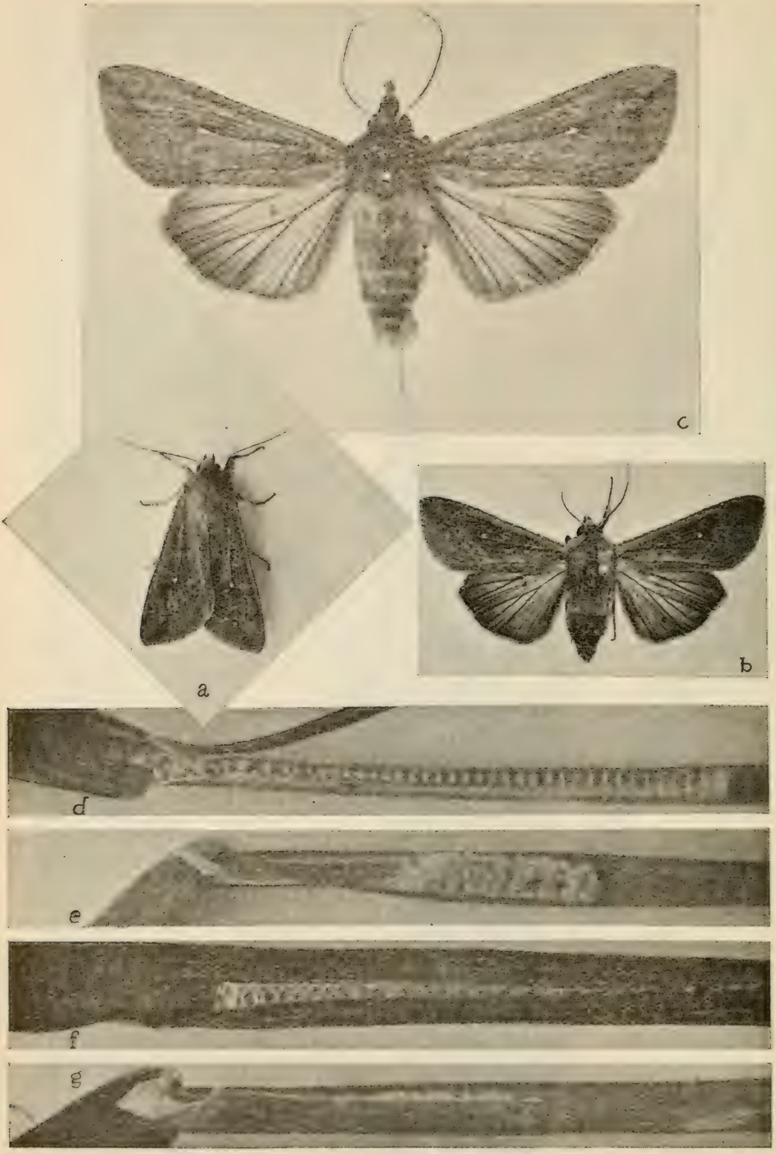


"June 27, 1743. There are millions of worms, in armies, appearing and threatening to cut off every green thing; people are exceedingly alarmed."

"July 1, 1743. Days of fasting are kept in one place and another, on account of the worms." *Extracts from the Journal of Rev. Thomas Smith, Falmouth, Me.*

By M. V. SLINGERLAND.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.




69.—*a, army-worm moth at rest, natural size; b, moth with wings expanded; c, the moth, twice natural size; d, e, f, g, eggs of army-worm moths as they are laid in grass leaves, much enlarged.*

# THE ARMY-WORM IN NEW YORK.

*Leucania unipuncta* Haworth.

Order LEPIDOPTERA ; family NOCTUIDÆ.

Perhaps no common name of an insect is so familiar to agriculturists and others as that of "army-worm." However, but comparatively few people are familiar with the story of an army-worm's life,—what it is, where it comes from, the wonderful transformations it undergoes, and many other interesting facts about it. The most serious outbreak of this insect known in the history of New York state and of the country at large occurred last year. As the newspapers teemed with more or less exaggerated accounts of its ravages and habits, it attracted unusual attention from all classes, resulting in a greater demand for definite, detailed, illustrated information than we were able to supply at the time. Fortunately we succeeded in breeding many of the insects through their different stages and broods in cages at the insectary, and were thus enabled to obtain many new and life-like pictures of army-worms, their parents, and other interesting phases of their life. In order that agriculturists and others may be prepared with definite information in case of future outbreaks of the insect in New York, the following account of its work in the state has been prepared.

## WHAT ARE ARMY-WORMS.

The name "army-worm" has been applied to several different insects which sometimes appear in great numbers and devastate large areas of field or orchard crops. The term is sometimes applied to the canker-worm in many localities in our state. However, what has come to be recognized as the army-worm proper or *the* army-worm by entomologists is shown at work, nearly natural size, in figure 68, and twice natural size in figure 70. It is a striped, sixteen-legged larva or caterpillar, resembling, and in fact, closely allied to, the well-known cutworms. It is aptly

called the "army-worm" because whenever it appears in injurious numbers, after destroying the vegetation in one field, the caterpillars always march like an army to other fields. The parents of army-worms are moths (see figure 69) which belong to a great family of insects known as Noctuids or owlet-moths. Most of the moths or "millers" that fly into our houses at night, attracted by the lights, are members of this family.

## THE CATERPILLARS AND THEIR PARENTS DESCRIBED.

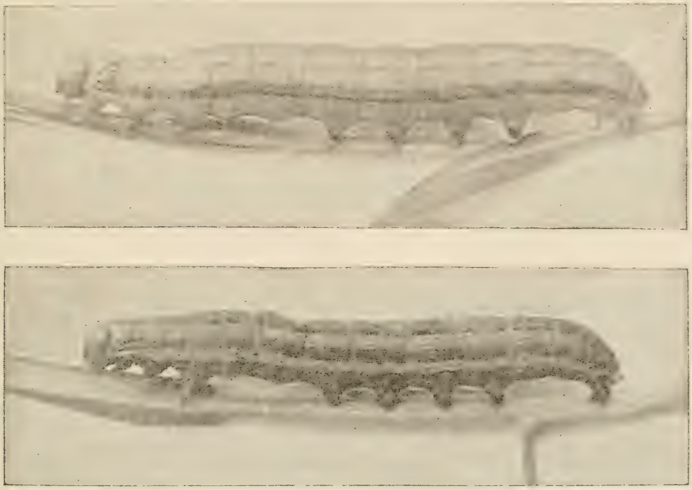
When full-grown, army-worms measure nearly an inch and a half in length. They are of a general greenish-black color, much lighter on the venter which is more or less mottled with blackish, and each side bears several distinct stripes.

Along each side of the body extend three stripes of about the same width; the one just below the spiracles is of a light greenish-yellow with whitish edges; the one bordering on the dorsum is a little darker with a mottled greenish-black center and narrow white lines along its edges; the central stripe, or the one with the spiracles in its lower edge, is black, sometimes lighter along its center. The dorsum is finely mottled with greenish-black and closely resembles the dark stigmatal stripe in color; along the middle line of the dorsum there extends a narrow white stripe, usually quite indistinct except on the thoracic and anal segments. The six true legs are light brown in color, and each pro-leg is marked with a large, shiny, blackish spot. The head is of a greenish-brown color, rather coarsely mottled with black which merges into distinct blackish stripes along the sutures.

There is considerable variation in general color among the caterpillars, some being much lighter than others, due to differences in the intensity of the stripes and the mottlings on the body. In some cases this difference was so great as to lead to doubts of the specimens being true army-worms. Two extremes of variation are illustrated in figure 70; in one instance all the army-worms received from one locality were like the one in the upper part of the figure, while those sent in from another army were all dark like the lower one.

The parent insect—the moth—is shown natural size at rest at *a*, and with wings expanded at *b*, in figure 69; at *c* in this figure the moth is represented twice natural size. As these figures indicate, the adult insect is a very plain little "miller." Its principal characteristic markings are the distinct white spot near the center, and the dark shade or stripe in the upper outer angle, of

each front wing. The general color of the front wings is clay or fawn, much specked with black scales; a row of more or less distinct black dots, one on each vein, crosses the wing about midway between the white spot and the outer margin; often the veins are outlined for a portion of their length by white scales. The hind wings are of a dusky brownish color, darker towards the outer margin, and with the veins blackish.



70.—*Light and dark varieties of army-worms, twice natural size.*

There are no differences in color between the male and female moths, but the abdomen of the female is more pointed, and her antennæ are much smoother than the hairy or ciliate antennæ of the male.

The moths are very uniform in their coloring and markings; practically the only variations are in the number of the black scales scattered over the front wings, and some moths are a trifle lighter or darker with more or less of a reddish or rust tinge. There is considerable variation in size, the distance across the outstretched wings ranging from a little less than one and a half inches to two inches. The moths bred from the lightest colored army-worms do not differ from those reared from the darkest caterpillars.

The moth may be readily distinguished from other similar

moths by the conspicuous white spot in the center of each front wing. It was doubtless this distinctive mark that suggested the specific name of the insect—*unipuncta*.

## HISTORICAL.

*Its general distribution and early history.*—Apparently the native home of the army-worm is in North America, although it is known to occur in England, South America, India, Java, Maderia, Australia and New Zealand, thus making it nearly a cosmopolitan insect. However, it is known as an especially injurious insect only in the United States, east of the Rocky Mountains and in Canada. "The region in which it especially flourishes extends from Iowa to Maine and from Texas to Alabama. East of the Blue Ridge Mountains its southerly range as an injurious species extends to North Carolina. The moth is often captured outside these limits and frequently in considerable numbers, but the caterpillar does not seem elsewhere to be a factor in agriculture."

What has come to be recognized as the first published account of this insect is quoted on the title page below the frontispiece. 1743 is always mentioned as the first army-worm year of which we have pretty definite proof. Perhaps it was the army-worm that appeared by the millions in Massachusetts in 1762 and ate up the corn. Graphic and definite accounts have been recorded of the ravages of the insect in New England in 1770 and 1790. The next army-worm year was in 1817, and since 1825 the insect has appeared in injurious numbers somewhere in the United States almost every year; but rarely, if ever, has the insect been destructive in the same locality in two successive years.

The army-worm was known in the early chronicles as "the black worm;" just when it came to be known as "the army-worm" we have not ascertained. Sometime in the latter part of the eighteenth century, a specimen of the adult insect—the moth—found its way into the then celebrated collection of a Mr. Francillon in London. Upon the breaking up and sale of that collection early in this century, this moth passed into the possession of a Mr. Haworth, who published a description of it in 1810; he named it *unipuncta*, the white speck.

It is a curious fact that no one seems to have discovered what the parents of the army-worms were like until 1855, when Mr. Kirkpatrick reared some of the moths in Ohio. It was not until 1861 that Dr. Fitch, then State Entomologist of New York, identified the army-worm moth as the same insect which had been described in England fifty years before.

*Previous army-worm years in New York.*—Apparently the first record of the occurrence of the army-worm in New York state is the following taken from the *Albany Argus* for 1817: "The black worm is destroying the vegetation in the northern towns of Rensselaer and the eastern section of Saratoga counties. Many meadows and pastures have been rendered by their depredations as barren as a heath."

The insect does not seem to have again attracted attention in our state for forty-four years or until 1861.* This is by far the most celebrated of the army-worm years, because the worms appeared in destructive numbers over an immense extent of country (twenty states were damaged to a greater or less extent), and also because this outbreak called forth several elaborate articles by the leading writers upon insects. In New York state the worms appeared in the vicinity of Buffalo, and at several other points towards the western and southern line of the state; and also in many places on Long Island.

In 1872, an army of the worms was reported from Tioga County. Again in 1875, which was a notable army-worm year throughout the country, the insect was very destructive in the same county and was reported as swarming on Long Island. Dr. Lintner states (*Country Gentleman*, 1877, p. 347) that the worms abounded in many portions of the state in 1876 and did serious damage, but the next year the moths were rarely seen. 1880 was also a notable army-worm year, especially in New York state. The worms were destructive in the southern and eastern counties of the state in August, and on Long Island the damage done in June was very great, creating much alarm. Bushels of the worms

* Dr. Riley states (3d Rept. Ent. Com., p. 95): "From an old number of the *Country Gentleman*, we learn that it did some damage in western New York." We have been unable to find this reference, nor does Dr. Fitch refer to it in his detailed account published in 1861.

were captured in post-holes dug in ditches on Long Island in 1880, but in 1881 scarcely any were seen on the Island.

In August, 1882, the insect appeared in formidable numbers near Saratoga Springs, and was also very destructive in Suffolk County. In 1885, the worms were reported as doing much damage in oats in Orange County. They next attracted attention in Orleans County in 1888, where they injured the barley crop twenty per cent. Two years later (1890) the worms are reported to have destroyed many acres of timothy in Queen's County. This completes the record of appearances in destructive numbers of the army-worm in New York state previous to 1896.

## NOTES ON THE OUTBREAK OF 1896.

During the spring and summer of 1896, the army-worm appeared in destructive numbers in portions of ten states, constituting what is probably the most serious outbreak of the pest known in the history of the country. In some states most of the damage was done in May, but usually it was the July brood which appeared in almost incredible numbers; in a few localities, however, it was not until September that the pest was seen in injurious numbers.

In New York state the outbreak was the most wide-spread and most destructive of any before recorded. We have authentic reports of armies of the worms having worked in forty-eight of the sixty counties of the state. We heard nothing of the insect in the state until about July 1st, when letters, telegrams, and even long-distance telephone messages began to pour in from all sections. A circular letter and telegram were prepared and for nearly three weeks in July, we were kept busy answering the urgent requests of the hundreds of correspondents whose crops, in many cases, were disappearing, often at the rate of an acre or more per day, down the throats of the armies of hungry worms.

Nearly all kinds of field crops were ravaged by the caterpillars. Corn and oats seem to have suffered the most; there is no data upon which to base any definite estimates, but one may safely say that thousands of acres of these two crops alone were ruined by the worms in New York. In many localities, rye, barley, wheat, millet, meadows, pasture lands, and Hungarian grass suffered

equally as much as, and in some cases more than, corn or oats. One army of the worms which we visited had stripped every leaf from forty acres of rye and had cut off one-third of the heads before the farmer discovered the presence of the enemy on his farm. When we reached his place, his corn and oats in adjoining fields were disappearing at the rate of an acre or two a day, and the lane across which the worms were marching presented a desolate appearance, scarcely a green blade of grass having escaped the jaws of the hungry horde. Many farmers had similar experiences with the insect. Often whole fields of rye or other crops would be ruined before the culprits were discovered. Some farmers, hoping to save their oat crop cut the grain before it was fairly ripe, binding it into bundles and "shocking it" as usual; but quarts of the worms simply gathered under and in these shocks and continued their destructive work on the drying grain, often ruining the whole crop.

The favorite breeding places for the worms are the low places in pastures and meadows where the vegetation grows the rankest, and in many cases it was evident that the armies started from such places in 1896. Often, however, the indications were that the worms were born in the rye or oat field where their ravages were first noticed. As there was nothing to indicate that 1896 was to be an "army-worm year," no one was on the lookout for the insect, and doubtless few, if any, farmers discovered the worms when they were small and before they had been forced to abandon their breeding grounds and march to new pastures in search of food to satisfy their voracious appetites. The larger proportion of the damage done in 1896 might have been averted had the farmers been able to apply remedial measures before the worms had spread far from their birthplace instead of when they were half-grown or more, with larger appetites, and were on the march.

Although the outbreak of the insect was so general all over the state, oftentimes the worms were confined to one or two farms in a town; one man's crops might be ruined by them while another army of the worms might not occur within a radius of several miles.

To fully realize the destructive capabilities of the insect one must see, no description will suffice, an army of the worms on the

march and at work. In most cases, the caterpillars in each of these armies must have been numbered by the millions; even an approximate estimate of the number of worms in a single army would have been impracticable. Oftentimes when an army was marching across a lane or roadway, nearly the entire surface of the ground for several rods would be covered with the crawling mass of worms; one could not step without crushing several of them. Is it to be wondered at that when such a vast horde of hungry creatures reach a field of young corn, acres of the plants soon look like the one shown in figure 68? They soon strip all the leaves from the stalks of oats, rye, and similar plants, and often cut off many of the heads, leaving them uneaten on the ground. In one instance, a barn loomed up before the worms directly in their line of march, but nothing daunted, many of them valiantly scaled the perpendicular wall and soon succeeded in getting over the eaves onto the roof. Here, however, they met their Waterloo, either from the exposure on the heated shingles to the sun's rays or from other causes, and a windrow of dead worms was formed under the eaves.

The worms feed mostly at night, remaining hidden during the day in the soil or under chunks of dirt or anything that will afford protection; many of them find shelter down in the cavities at the bases of the unfolding corn leaves. On cloudy days the worms usually feed during the day, and often many of the worms may be found at work on sunshiny days.

In almost every case it was the July brood of worms only which ravaged crops; apparently in none of these instances did the May or the September broods of the caterpillars attract attention. However in at least two localities (Cheviot, Columbia Co. and Warwick, Orange Co.), it was only the September brood of worms which were numerous enough to be noticeably destructive; curiously enough the insect had not been seen in these localities before during the year. Thus, while in most localities all of the damage was done in July, and in a few places the worms were not injuriously numerous until September, it is to be noted that we have no evidence that more than one of at least three broods of the insect was noticeably injurious in any locality during 1896. A probable explanation of this noteworthy fact will be brought

out later on in the discussion of the enemies of the army-worm.

## INDICATIONS OF THE PRESENCE OF ARMY-WORMS.

Unfortunately, even when army-worms occur in immense numbers, farmers rarely become aware of their presence until they are about half-grown, when they have usually spread some distance from where they hatched, and have often already done much damage. Last year, one farmer noticed that a forty-acre field of rye seemed to be ripening unusually early, but he did not discover the cause until a few days later when an immense army of the caterpillars began marching from this field into adjoining corn and oat crops; an examination of the rye showed that the worms had eaten nearly every rye leaf in the whole field and had also cut off about one-third of the heads. That the insect gets such a start before it is discovered, is doubtless largely due to the fact that it is not a "standard" pest (that is, one which may be expected in injurious numbers almost every year, like the Codlin moth) and thus farmers, not expecting it, are not on the lookout for it. As it is impossible to predict with any degree of certainty when army-worms may be expected, this unfortunate condition of affairs seems to have no practicable remedy.

A whole army of the worms are often hatched in a few square rods or less of rank growing grass in a low, damp spot in a large pasture or meadow. Such a small area is easily overlooked, although the little caterpillars may have eaten enough of the grass to enable one, on the lookout for them, to readily discover their presence before they have spread far and have done much damage. It would be an easy matter to check an army of these very destructive worms in field crops if it could be discovered before it had spread far from its comparatively small breeding ground.

## WHAT ARMY WORMS EAT, AND THEIR CAPACITY FOR INJURY.

Army-worms include in their menu a wide range of food-plants. They seem to prefer the grasses and grains. Timothy, wheat, oats, corn, rye, and barley, they seem to relish best; and millet, Hungarian grass, sorghum, or flax do not come amiss. They have also been known to eat onions, peas, beans and other garden

crops. Cranberry crops have been greatly damaged by them, and in one instance "an army of the worms, in passing through a strawberry patch, devoured both the leaves of the plant and the unripe fruit." Experiments have shown that in confinement the worms will live, thrive, and undergo their transformations when fed exclusively upon either the garden poppy, beet, lettuce, cabbage, raspberry, onion, parsnip, radish, carrots, or pea. They refused to feed, however, on bean, cotton, grape, and hemlock.

Ordinarily clover is not eaten by the worms ; it is said that "a timothy field is often eaten to the ground, leaving the clover scattered through it standing." In 1880, however, a remarkable exception occurred in New Jersey where in some localities clover-eating by the worms was the rule and not the exception.

Fruit growers have little to fear from this pest. In one case, as mentioned above, a strawberry bed was injured by an army of the worms, and there is but one record of their having eaten the leaves of fruit trees.

Finally, it may be of interest to know, that when on the march, the worms have been known to not hesitate at cannibalism to satisfy their hunger, and many individuals have been killed and devoured by their stronger comrades.

It is a striking fact, that, although the army-worm is widely spread throughout the world, it is notably destructive only in the northern half of the Uuited States ; and in this section, its capacity for injury is very great. Almost every year it appears somewhere in this area and injures crops to the amount of hundreds of thousands of dollars. As one can readily understand, it is a difficult matter to estimate the loss occasioned by the ravages of an insect over a large area. The damage done by the army-worm in western Massachusetts in 1861 has been estimated at $500,000. The oat crop of Indiana and Illinois is estimated to have been damaged by the insect in 1881 to the extent of about $750,000. We have but little data upon which to base an estimate of the injury done by the worms in New York in 1896. It has been stated, however, that the damage from the insect in Massachusetts last year would amount to upward of $250,000 ; and we believe that at least as many dollars worth of the crops of timothy, oats

and corn of New York farmers also went down the throats of the ravaging armies of the worms in 1896.

## THE STORY OF AN ARMY-WORM'S LIFE.

Only those who have closely watched the growth and wonderful transformations of an insect can realize how fascinating is such a study of life. It is astonishing how much ignorance there is among the great mass of the people in regard to insects and their life-stories. But few of the hundreds of farmers who suffered from the ravages of the army-worm last year, had any definite ideas as to where the worms came from or what became of them. Our observations lead us to believe that those who know the most about the habits and lives of their insect pests, are the ones who best succeed in conquering these minute foes. Furthermore it must be more interesting to plan a campaign against an enemy with whose habits one is familiar than to go at it haphazard as many do. The life-history of the army-worm varies somewhat in different latitudes; the following discussion is applicable, in most cases, only to New York state and similar latitudes.

*The egg stage, or how and where its life begins.*—Each army-worm begins life in a minute, round, nearly smooth egg of a distinct, yet very light yellow color,* and measuring from 6 mm. to 7 mm. (about .025 of an inch) in diameter. In seeking a place to lay her eggs, the mother insect seems to preferably choose the rankest tufts of grass in pastures or where the growth is the rankest in grain fields or meadows. Finding a suitable stalk of grass or grain, the moth clasps a blade or leaf with her legs and then deftly thrusts her ovipositor into the as yet unfolded base of the leaf or more often down into the sheath where it surrounds the stalk. She is thus engaged from one to four minutes at a spot. During this time from 10 to 50 or even more eggs may be laid and covered with a thin white glutinous substance which fastens them together and also draws the sides of the leaf close around them,

* The egg has always been described as smooth and white. Yet the hundreds of eggs which we have seen had a distinct yellowish tinge, and under the microscope the surface of the shell was prettily marked with a net-work of very fine striæ or ridges; the white substance with which the moth covers her eggs obscures this net-work.

so that nothing but a narrow glistening white streak is visible, as shown much enlarged at *f* and *g* in figure 69. At *d* and *e* in the same figure, part of the sheath of the leaf has been removed to show the eggs and their glutinous covering. Observations indicate that most of the eggs are laid during the earlier part of the night, the moth remaining hidden during the day. It is also said that early in the season the moths prefer to oviposit in the cut straw of old stacks, in hayricks, and even in old fodder stacks of corn or in old bits of corn stalks scattered about in pastures; eggs have also been found in the spring in young grain.

The immense numbers in which the army-worm often occurs would lead one to suspect that the parent moth must be quite prolific. Careful observation has shown this to be true, for as many as 737 eggs have been found in the body of one moth. They develop rather slowly in the ovaries, as a week or more often elapses between the time of emergence of the moth and the commencement of egg-laying.

Eggs laid in the sheath of grass-blades in our cages in November hatched in from 8 to 10 days. This agrees with other records.

*Growth and peculiar habits of the worms.*—A day or two before the eggs hatch, the brown jaws of the developing caterpillar can be plainly distinguished through the shell.

The newly hatched worms are nearly 2 mm. (.078 of an inch) in length and are of a translucent whitish color. The head is of a dark brown color and the thoracic shield a little lighter. There are no indications of the stripes which mark their body later. The first pair of abdominal pro-legs are only about one-half as large as, and the second pair are slightly smaller than, the last three pairs. All these undeveloped pro-legs bear the usual hooklets, but whether all are functional or not, we have not determined.

In moving, the little caterpillars loop along like measuring-worms, and when disturbed they drop themselves down at the end of a silken thread which they spin, like canker-worms. As we had seen nothing recorded that would indicate such a habit, we were surprised to find that for the first day or two of their life the caterpillars fed upon the shells of the eggs from which they had just hatched and upon the white glutinous substance which surrounded the eggs. In each case under our observation the little worms ate almost every vestige of these substances before they attacked the live grass leaf. Soon after they began feeding upon the grass, this green food gave their bodies a greenish color. After feeding for a few days, the little worms moult or shed their skin. In the second stage of their life as a caterpillar they have the same looping and spinning habits as before, and the stripes of

the future mature worms begin to appear. After the second moult occurring 3 or 4 days later, or in the third stage, the caterpillars are more distinctly striped, their looping habit is lost, but the front pro-legs are still the smallest, and instead of spinning down when disturbed, the worms curl themselves up. When they reach the fourth stage, 3 or 4 days later, they have many of the characteristics of the mature caterpillars, shown in figure 70, and the pro-legs are of nearly equal size. Two more moults occur at intervals of 3 or 4 days before the worms become full-grown.

This insect thus usually spends from twenty to thirty days of its life as an army-worm or caterpillar.

Army-worms occur every year in most grass-lands, but their habits of feeding mostly at night, remaining hidden during the day, and of dropping when disturbed, render them quite difficult to find unless they occur in large numbers; when young the worms quite closely mimic their food-plants, which also renders their detection less easy. It is said that sometimes one may pass daily through a grass plot where the worms abound, and never suspect their presence until the plot begins to look bare in patches. Their night-feeding habit reminds one of their near allies in the insect world—the cutworms. But the army-worms do not seem to exhibit the wasteful cutting habit of the cutworms, except when they sometimes cut off the heads of wheat and similar grains; usually only the leaves of the grasses and grains are eaten.

The fact that the traveling of the worms in large armies is an abnormal habit, cannot be too strongly insisted upon. It is only when so very abundant, and the food of the vicinity in which they were borne is destroyed, that they march in search of further supplies; they are usually from one-half to two-thirds grown when the march begins.

The rate of travel of the worms when on the march of course varies with the nature of the surface over which they have to crawl. They have been observed to travel at the rate of from one to nearly three feet in a minute, or from four to ten rods per hour.

*The Transformations Through the Pupa Stage to the Adult Insect.*—Soon after reaching its full growth, an army-worm ordinarily burrows into the ground for an inch or two and there twists its

body about until a smooth cavity or cell is formed. In this earthen cell the caterpillar sheds its skin for the last time and becomes a dark brown, apparently lifeless object—the pupa—shown natural size (at *a*) and enlarged in figure 71. In the latter part of July last year many farmers reported that the army-worms had suddenly left their fields and had disappeared; this simply meant that they had gone into the ground to pupate. When the worms occur in great numbers, many of them change to pupæ under stones, boards, chunks of dirt, or rubbish of any kind, without entering the ground; at such times more or less silk is sometimes spun around the body and particles of earth adhere to it thus forming a slight cocoon. The length of time the insect remains in the pupa state varies with the climate and the season. In the spring and fall the pupa stage apparently lasts from three to four weeks in New York state, while in July only from ten to fifteen days was spent by the insect as a pupa last year.


71.—*The pupae into which army-worms transform. Natural size at* a.

*Habits of the moth.*—Soon after emerging from their cramped quarters in the pupa, the moths gradually expand their wings and may be seen, resting quietly, hidden during the day in the grasses, in the position shown at *a* in figure 69. The moths usually begin flying about sunset and are doubtless active during the greater part of the night. Their flight is low and is characterized by a quick darting motion. Upon first alighting the wings are kept in motion with a rapid quivering for a moment. They do not appear to be as readily attracted by lights as many other moths. In our extensive trap-lantern experiments conducted in

1889 and 1892, only *one* moth was attracted to the lanterns during the two years.

Doubtless the army-worm moths that emerge in the spring and summer do not live more than two or three weeks; some of them which emerge in the fall live all winter in hibernation. They are fond of liquid sweets, such as a sugar solution painted upon trees to attract other insects; and last year in southern New Jersey they were found in large numbers among the plant-lice on melon vines, doubtless attracted by the "honey dew" secreted by the aphids. They undoubtedly feed upon the nectar of various flowers for they have been taken in the evening upon the blossoms of clover and soap-wort; they have also been found feeding on the blossoms of apple, honeysuckle, and yucca. In August we tried to persuade the moths to lay eggs in our cages where there was no food for them, but all died without ovipositing. We fed the moths which emerged in the fall with sweetened water and they oviposited freely in the cages.

*The number of broods of the army-worm in New York.*—The army-worm apparently did not attract attention in any locality in New York in 1896 until about July 1st. Then the worms were half or two-thirds grown and had begun to march in armies. From some of these caterpillars we reared the adult insect as early as July 25th, and many moths continued to emerge until about August 15th. We failed to induce these moths to lay eggs, as noted above. In most localities the insect was not noticed again in 1896, but from two places reports reached us, on September 14th and 29th, of the ravages of armies of worms. These were evidently the offspring of the brood of moths which emerged in the latter part of July and the first week in August. From some of the September armies of the worms, moths emerged in our cages from October 31st until November 18th. November 9th, we saw a pair of moths in copulation, and by the 11th the female had laid many eggs on the grass leaves. By the 20th of the month some of the eggs had hatched; other eggs hatched as late as the 27th. Ordinarily this would be rather late for the little caterpillars to obtain food, but last year the weather was favorable at that late date and continued so for some time, so that the

worms fed for several days on the grass leaves before the autumn frosts forced them to prepare for hibernation.

The above observations clearly show that at least two broods of army-worms appeared in New York in 1896, one in July and a later one in September. However, across our southern border, in New Jersey, several armies of the worms ravaged crops in May. Although no noticeable injury seems to have been done by the insect last year in New York before July, their appearance in New Jersey in May and our observations on their habits in the fall are quite conclusive evidence that there must have been at least one brood of the caterpillars previous to July in our state.

We are thus led to conclude that three broods of the army-worm ordinarily occur in New York state. The first brood of the caterpillars are doubtless at work in April and in an "army-worm year" may be forced to march in search of new supplies in May in some localities. This May brood of worms transform early in June into the moths which lay the eggs from which hatch the second brood of worms that were so destructive in July last year. Finally, a third brood of caterpillars, the progeny of the moths from the July brood of worms, work in September.

*The most destructive brood.*—Usually the second or July brood of the army-worms is the destructive one in New York state and similar latitudes. The first or May brood was noticeably destructive in some localities in New Jersey and Illinois, but seems not to have attracted attention by its injuries in New York. Ninety-five per cent or more of the injury done by the army-worm in New York last year was the work of the second or July brood. In at least two localities, however (Cheviot, Columbia Co., and Warwick, Orange Co.) it was only the September or third brood of the worms which did noticeable damage in 1896. Owing to the activity of their enemies and to other causes, rarely is there more than one *injurious* brood of the insect during the year, and as stated above, this is usually the second or July brood. Thus in those localities which suffer from the ravages of either the first (May) or the second (July) brood of the caterpillars, usually no more armies will be seen during the rest of the season. This is a very important phase of the question for upon it may depend the answer to the question so often asked in July last

year: Will it be safe to plow under our ruined crops and attempt to grow a late crop of something? This question is discussed further on.

*How the insect passes the winter.*—Our observations, detailed above in discussing the number of broods, further confirm previous records of the hibernation of the insect as a caterpillar. The indications are that in the latitude of New York most of the worms that hibernate are small, not more than half grown.

Among the many records of the capture of the moths, there are but two of their appearance in New York state earlier than about the middle of June; one moth was bred at Albany about the middle of May and we captured one at light on June 2d. This would indicate that the insect does not pass the winter as a moth in our latitude. But the moths have been found in New Jersey "during the entire winter in sheltered places" (Rept. of Entomologist of N. J. Expt. Station for 1896, p. 450). Some writers believe that the insect may also winter as a pupa, but no conclusive evidence has yet appeared to prove this.

Thus the army-worm doubtless hibernates in New York state either as a young caterpillar or in the moth stage; possibly some pupæ winter over.

*Briefly summarized* then the life-history of the army-worm in New York state seems to be as follows: the moths which may hibernate oviposit early and the caterpillars which hatch from these eggs augmented by the somewhat larger ones which were born late the preceding fall and hibernated, form a May brood of worms that may possibly be numerous enough some years to necessitate their marching to new feeding grounds. The caterpillars of this first brood undergo their transformations through the pupa stage to the adult insect or moth early in June; and the progeny of these moths form a second, and often injurious marching brood of the worms in the early part of July. A third brood of the worms, which are rarely injurious, is developed in September, and the moths into which these transform may lay eggs from which will hatch the young caterpillars that hibernate, or some of the moths themselves may hibernate and oviposit in the spring.

## THE NEXT ARMY-WORM YEAR.

Will the army-worms come again next year? In 1896, this was the question uppermost in the minds of many New York farmers whether they suffered from the ravages of the insect during the year or not. This spring there are reports from some localities in the state that farmers are planning to not sow oats and other grains for fear of another invasion of the worms this summer. Of course, no one can say definitely when New York crops will again be ravaged by the pest. Many of our insect foes may come one year in very destructive numbers, but it often happens that the next season we see or hear very little of them. The prevalence of insect life may be likened to a pendulum that swings irregularly in response to the action of some of nature's forces; in the case of insects, their parasitic and predaceous enemies and the variation in their food supply and in climatic conditions are among these forces. However, man has not yet been able to formulate these "ups and downs" so that he can rarely predict with any certainty whether an insect will appear in injurious numbers at any time, even though it may have appeared in very destructive numbers only the year before. This is especially true of the army-worm. No one can predict when we will or will not have an "army-worm year." It has been noted that often an outbreak of the worms has occurred during years which had an unusually dry spring and were preceded by an abnormally dry year; a dry spring gives a more favorable opportunity for the development of the little hibernating caterpillars and those which may hatch early from eggs laid by moths which hibernated. But this combination of climatic conditions does not invariably bring army-worms in injurious numbers.

Since 1825, the insect has appeared in injurious numbers somewhere in the country nearly every year. It has also been injurious somewhere in New York state at intervals of from one to three years since 1872. But, and here is an important historical fact, *rarely if ever, has it ravaged crops in the same locality during two years in succession.* There has been only three general outbreaks of the insect in New York; those occurred in 1861, 1875, and 1880. The other outbreaks were mostly confined to a county

or two. Thus from the historical record of the insect, one might justly conclude that 1897 will not be an "army-worm year" either in our state or in the country at large. Doubtless armies of the worms will appear in very limited localities in some parts of the country but quite probably not on the same farms that were ravaged last year.

There are other reasons for thinking that farmers, whose crops suffered last year, need not lose any brain matter in worrying over the possibility of another "army-worm year" in 1897 or for several years to come; in many cases the worms had not been seen on these farms, until last year, since 1861 or 1875. There is no doubt but what another brood of the worms appeared in New York after the very destructive brood which worked in July. But in those localities where the insect was so destructive in July, apparently nothing was seen of the caterpillars of the next brood which worked in September; they were not numerous enough to attract attention by their injuries. There must have been a fearful decimation among the many millions of worms constituting the July armies either about the time they became full grown or when they had reached the next or pupa stage. And there was. If there had not been, at the normal rate of multiplication, there would have been enough caterpillars developed in September to have caused the ravages of the July brood to have appeared insignificant in comparison. The principal causes of this great decimation in the ranks of these armies of worms are discussed under the natural enemies of the insect. Suffice it is to say here, that as some of the same causes worked upon the September brood, we believe that the number of army-worms which went into hibernation last fall in New York state was not materially greater than in other years when nothing is heard of the insect the year following.

In short, we believe that the history of the insect and the evident and very effective work of its enemies last year, in New York at least, strongly indicate that the army-worm will be a scarce article of diet for the birds in 1897 and for some years to come in most parts of our state. At any rate, we would strongly advise farmers to not hesitate a moment about sowing grain crops

for fear of the worms either in 1897, 1898, or for the next decade, for that matter.

## USES THAT MAY BE MADE OF INFESTED FIELDS.

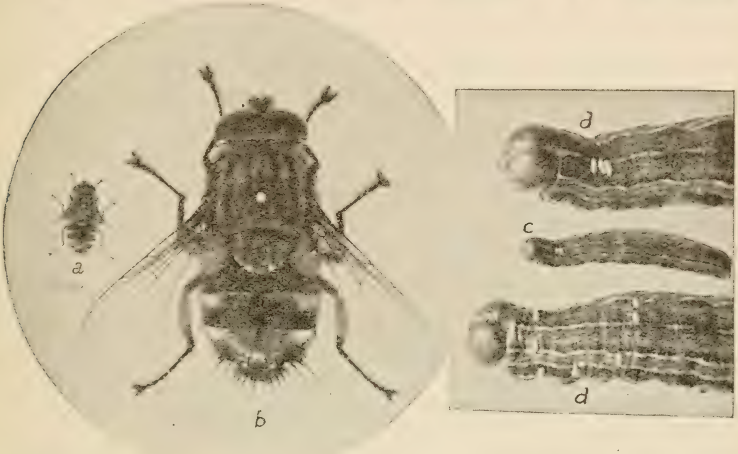
Last year many farmers were at a loss to know what use to make of a crop that had been invaded by an army of the worms whose ravages it was then impossible to check. Those who cut their oats and "shocked" them in the usual manner, hoping that this would check the work of the pest, were doomed to disappointment for the worms continued to work in the shocks, doing much damage. Infested crops of oats and other grains may be cut, and made into hay, or put into silos. This procedure will not facilitate the further multiplication of the insect any more than if the crops were not harvested. What few worms are made into hay or go into the silo will not deleteriously affect the hay or silage.

In many localities in New York state, the great destruction wrought by the worms resulted in a decided shortage of fodder for stock for the fall and winter. Hence, many inquired in July last year what crops, if any, could be grown on the same fields that year. In many cases a shortage of this kind may be partially overcome by putting in at once crops of millet, Hungarian grass, or turnips. Sow from 3 pecks to a bushel of the first two, and about 5 pounds of the latter per acre. If the infested field is plowed, well fitted, lightly harrowed and rolled, and treated to a dressing of fertilizer containing a relatively high per cent. of potash and nitrogen, good crops of these stock foods may be obtained before the winter. Should the turnips be too thick, cultivate by harrowing one or more times soon after they come up. Oats and peas mixed and treated in like manner may also succeed. As the September brood of the worms is rarely numerous enough to be destructive in our state, crops sown in the latter part of July or in August will rarely suffer from the army-worm.

## NATURAL ENEMIES.

What a feast many of the birds, including chickens and turkeys, had last year in those localities where the army-worm was numerous. On July 23d, Mr. L. T. Yeomans, of Walworth, N. Y., wrote

us: "We think we have disposed of the greater share of our army-worms. The birds were our greatest helpers. They came in flocks—blackbirds, thrushes, and even the English sparrow condescended to help." Mr. F. A. Sirrine, of the New York Experiment Station staff, has reported that in addition to the birds just mentioned, the cowbird, catbird, robin and the lark were seen feeding on the worms at Washingtonville, N. Y. He states:




72.—THE FARMER'S FRIEND. *The red-tailed tachina fly* (*Winthemia 4-pustulata*). a, *the fly, natural size;* b, *the fly, much enlarged;* c, *army-worm upon which the fly has laid eggs, natural size;* d, *parasitized army-worms, enlarged.*

"It was at first doubted whether the sparrows were in the oat field on a legitimate errand, but close observation showed that each old bird was carrying from one to four worms to its young." After an army's onward march has been checked by the measures discussed under the next heading, then turn in all the chickens and turkeys in the neighborhood.

Among the other vertebrate animals, hogs, toads, and frogs often come in for their share of this dainty food.

Army-worms are also preyed upon by many different kinds of insects. A large number of predaceous beetles (including in many cases their grubs also) often gather about an infested field and greedily feed upon the worms.

An unusually large number of true parasitic insects attack the

army-worm, and they are the most destructive of its natural enemies.

Wherever the worms abound or are on the march, they are usually accompanied by two-winged flies (one is shown natural size at *a*, figure 72), which are often so numerous that their buzzing reminds one of that of a swarm of bees.* These tachina flies are usually the most important and effective of the enemies of the army-worm. A careful examination of a hundred worms in almost every army that ravaged crops in our state last year would have revealed the fact that from ten to seventy-five, or even more in some cases, of them bore upon their backs near the head small white eggs stuck fast to the skin. At *c*, figure 72 is shown a caterpillar bearing three of these eggs natural size; the same eggs are shown enlarged, in position, at *d*, above *c*, and another worm bearing seven similar eggs at *d* below *c*. As many as eighteen of these eggs have been found on a single army-worm, but five is about the usual number. These eggs are stuck to the caterpillar's skin by the tachina flies which buzz around a worm until a favorable opportunity occurs when they swoop down and quickly stick on an egg. Doubtless the eggs are placed near the head to prevent the worm from getting at them with its jaws. From these eggs there soon hatches a maggot which bores its way through the caterpillar's skin and then revels in the juices and fatty tissues of the body, gradually sapping the life of the worm. But few of the army-worms which bear these tell-tale marks—the eggs—of

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*Two species of these flies were apparently about equally numerous in infested fields in New York last year. One species, the red tailed tachina fly (*Winthemia 4-pustulata* Fabr.), is shown natural size at *a*, and much enlarged at *b* in figure 72. It was first described in this country by Kirkpatrick in 1860, but Mr. D. W. Coquillett has recently stated that it is an European species and was described by Frabricius in the last century. Mr. Coquillett sends us the following synonyms for this insect: *Exorista leucaniae* Kirk.; *Senometopia militaris* Walsh; *Exorista cecropiæ* Riley, M. S.; *Tachina deilephila* O. S.; *Exorista infesta* Williston; *Chaetolyga rufonotata* Bigot; *Chaetolyga rufopicta* Bigot; *Exorista ciliata* Townsend; *Exorista platysamiæ* Townsend; *Exorista datanæ* Townsend.

The other species closely resembles the one just discussed and is known as the yellow-tailed tachina fly (*Belvosia unifasciata* Desv.). It was first described as *Exorista flavicausa* by Riley, but Mr. Coquillett has recently found that Riley's type is the same insect as *B. unifasciata* Desv.

these little parasitic flies, ever succeed in reaching the pupa stage; usually the maggots of the parasites get full grown and leave the caterpillar's body about the time it is also full-grown. The maggots burrow into the ground beneath their host's body and in a few days undergo their transformations to the adult fly.

The deadly work of these tachina flies, of course, does not culminate until the worms have done about all of their damage, but the further development of the insect is stopped and thus the danger of another brood of army-worms is averted. New York farmers were greatly indebted to these little tachina flies last year, or so effectively did they work on the July brood of worms that we believe the comparative insignificance in the numbers of the September brood was largely due to the efforts of the little flies in July. In other words, had it not been for the work of these flies in July, we believe many New York farmers would have suffered from similar armies of the caterpillars in September.

The question has been asked: What do these tachina flies feed upon when the crop of army-worms is comparatively insignificant? The yellow-tailed tachina fly seems to have been bred only from the army-worm, but the red-tailed species is known to work upon at least thirteen other kinds of caterpillars.* Doubtless the former species also has other hosts, and thus when there is a shortage in the army-worm crop, these tachina flies have other choice delicacies in the worm line that may be substituted in their menu.

There are several species of minute four-winged flies which are also parasitic upon the army-worm. The flies "sting" their eggs through the caterpillar's skin, and the grubs that hatch live within the body of their host; when they issue, they spin small, oval, white, silken cocoons attached by loose silk to some neighboring object. As many as ninety-six of the grubs may find

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* Dr. L. O. Howard writes that this tachina fly has the following hosts: *Deilephila lineata* Fabr.; *Protoparce carolina* Linn.; *Philampelus pandorus* Hueb.; *Alypia 8-maculata* Hueb.; *Attacus promethea* Drury.; *Attacus cecropia* Linn.; *Orgyia leucostigma* S. and A.; *Datana ministra* Drury.; *Adoneta spinuloides* H. S.; *Peridroma saucia* Hueb.; *Feltia herilis* Grote; *Leucania unipuncta* Haw.; *Laphygma frugiperda* S. and A.; *Hemaris diffinis* Boisd.

sustenance in a single army-worm. Sometimes these little parasites are so numerous as to be of much help in checking the pest. Some of the large ichneumon flies also attack the army-worm.*

Last year, in some parts of the state, thousands of the army-worms and many more of their pupæ were killed by a bacterial disease, sort of an insect cholera; the interior of worms and pupæ affected with this disease appeared rotten.

## How to Fight the Army-worm.

As army-worms are not easily and not often discovered in the comparatively limited area in which a whole army of them may breed, a farmer's crop of many acres may be thoroughly infested with a ravenous army before he is aware of it. Where the worms have thus taken possession of a field, but little can be done to destroy them which will not also involve the destruction of the crop. If the surface of the soil were smooth and hard enough, the drawing of a heavy roller over the field would crush many of the worms, but this "roller process" is not often nearly so effectual as it would seem to be theoretically. A flock of poultry turned into the field would lessen the numbers of the worms somewhat.

However, the worms can be prevented from entering other fields, and may, in many cases, be checked and killed even after they have entered a new field; in some cases, especially in corn fields, an advancing army may be stopped in the middle of the field and thus half of the crop saved. The simplest and most effectual method of doing this is to either dig a smooth-walled ditch, or plow several deep parallel furrows in front of the invading army; the perpendicular, smooth side of the plowed furrow should be towards the field to be protected. The worms not being readily able to scale the perpendicular wall of the ditch or furrow will drop back and begin crawling along the bottom seeking an easier place of ascent. If deep holes have been dug in the ditch or furrow at intervals of a few feet, the worms,

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* We bred several specimens of *Meteorus hyphantriae* Riley from army-worms. This insect and its curious suspended cocoons were illustrated on plate IV, *a*, *b*, *c*, of bulletin 123.

in their wanderings, readily tumble into these holes and cannot get out. Bushels of them have been trapped in this way, and then killed with a little kerosene or by burning some straw scattered along the furrow. The holes or pits in the furrows are very essential to the success of this preventive method. It has been aptly said : "To one who has never before seen the army-worm in its might, the sight of the myriads as they returned thwarted in their endeavors to cross a ditch or furrow, or of the living, moving, and twisting mass which sometimes fills a ditch to the depth of several inches, it is truly interesting." In some soils a little extra work will be necessary to keep one side of the furrow perpendicular and to keep the earth loose and friable in the furrow ; some accomplish the latter by dragging brush along the furrow. A ditch or several furrows well taken care of in this way will afford an almost impassable barrier to the worms, as many, who followed the directions carefully last year, can testify. It is such an easy matter to make a furrow and as one is not so effectual a barrier as a ditch, we advise that two or more parallel furrows be made, so that the worms which may scale the first one will be confronted by another.

A strip of coal tar will effectually stop the worms as long as it remains sticky, but it has to be renewed once or twice a day and is thus expensive. There were some reports that the worms would not cross a strip of salt, and that when sprinkled with salt they die. Mr. Wm. R. Huntington, Rome, N. Y., reported to us the following experiment with salt: "After hearing that salt would kill them, I took a pailful and went into a corn field where there were lots of worms. I found some on the ground and put salt all around them and on them. They would curl up and after a short time, a minute or two, would crawl away as lively as ever. I next went to some hills of corn that were badly eaten and covered with worms. I put at least a handful of salt on a number of such stalks, covering up many of the worms, but I could not see that it had any effect upon them. The next day I found the same worms, apparently, eating close to the salt. I had already put a ditch around this piece which held them where they were, so I did not experiment any farther with salt, not having any faith in it." Whenever practicable, it is always a good plan to make a

ditch or furrows around the whole field or the worst infested section of the field and thus confine the worms as Mr. Huntington did. Then turn in your poultry or poison the worms. Our little parasitic friends often do noble work in checking the future development of the insect, but they do not give the immediate relief which the farmer usually needs.

When the worms can be confined to a small area by a ditch, it may be practicable to spray this area with a strong Paris green mixture to poison the worms. Sometimes much can be done to lessen their numbers by drenching with Paris green a narrow strip of the crop on the side toward which the army of the worms are marching, or even a strip just ahead of the worms in an infested field. A bran mash, to which enough Paris green has been added to give it a distinct greenish tinge, scattered about where the worms are at work will attract and poison many of them.

In fighting army-worms, it is necessary to act quickly, for a day's delay often means the destruction of an acre or more of a promising rye, corn, oat, or hay crop. Stop the onward progress of the worms, or confine them in a limited area if practicable, with ditches or deep furrows in which holes have been dug every 10 or 15 feet. Then kill as many of the worms as possible, either in the holes in the furrows, or by the use of poisons, or invite the poultry to a feast.

MARK VERNON SLINGERLAND.

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Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

HORTICULTURAL DIVISION.

# Strawberries under Glass.

By C. E. HUNN and L. H. BAILEY.



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The regular bulletins of the Station are sent free to all who request them

## BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
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131. Notes upon Plums for western New York.
132. Notes upon Celery.
133. The Army worm in New York.
134. Strawberries under Glass.

CORNELL UNIVERSITY, ITHACA, N. Y.,
April 23, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY:

*Sir:* The ensuing paper is submitted for publication under Chap. 437 of the Laws of 1896.

The bulletins which have been issued under the Experiment Station Extension Bill have been of four general types,—those which have attempted to improve the cultivation of staple or well known crops, which have endeavored to interest the farmer in the amenities of rural life (as the flower and tree-planting bulletins), those which aim to expound well known facts and principles, and those, like the present, which suggest new avenues of profit. There of are, of course, no hard and fast lines dividing these classes of bulletins, and it is hoped that the total effect of them has been educative. The writer will be glad if they have opened new and pleasant lines of thought to the dweller in the country, and have thereby given him any new incentives to live and work.

Several years ago, the writer undertook the investigation of the winter forcing of vegetables, and whilst that type of experiment is not to be discontinued, it is nevertheless to form a very subsidiary part of the work in the next few years. That ground has been fairly well traversed. He now drops the Experiment Station Extension work by suggesting a new field of experiment,—the winter forcing of fruits.

L. H. BAILEY.

73.—*Bench of Beder Wood strawberries, in 6-inch pots. Berries supported by sections of wire screen. See, also, the picture on the title-page.*

# STRAWBERRIES UNDER GLASS.

During the past winter we made an attempt upon a considerable scale to grow strawberries under glass. The attempt was so successful that the methods which were employed in the raising of the crop are here detailed. The experiment was made under difficulties from the fact that we have no house especially adapted to the purpose, the climate of Ithaca is excessively cloudy,* and we also had no well-established strawberry plants of the varieties which we desired from which young plants could be raised. Consequently the berries were grown in two houses which were too high and rather too dark for their best development; and the plants were taken from stock which was set late in the spring of 1896. It is probable that best results are to be secured from runners of maiden plants which are set very early in the spring or in the fall before.

The stock plants from which runners were taken were set on the 6th of May in rich and mellow ground, but the season turned out to be very dry and the plants made less growth than they would have made in a normal season. Three lots of plants were grown from this stock, as follows: The first lot was grown in 2½ inch pots plunged under the runners on July 10th; the second lot was from pots plunged on July 27th; and the third from those plunged on August 22d. After having grown in these pots for a period of about two weeks, the plants were taken up and shifted into 4-inch pots and were then put in frames. The frames which we used for this purpose were simply common cold-frames, upon which no glass was placed until very cold weather came on.

The first lot of plants was taken to the frames on the 24th of July; the second upon the 21st of August; and the third lot upon the 11th of September. The plants were shifted again into 5-inch and finally into 6-inch pots, and in the latter size they were

* From December 1st to February 1st there was not a full day of clear sunshine.

brought into the forcing-houses and carried through to fruiting. The first lot was shifted from fours to fives on the 8th of September, and from fives to sixes on the 26th of September; and the other lots received similar treatment.

The plants were allowed to remain out of doors until nearly mid-winter, with no more protection than a covering of glass during the very coldest times. It was the desire to give them a very thorough rest by allowing them to freeze perfectly solid. We are not at all sure that this freezing is essential. In fact, the probability is that berries can be raised about as well without it; but it is very probable that a decided check or rest to the plants before they are taken to the houses will add greatly to their productiveness and strength, and freezing may be expected to destroy red spider and other pests.

On the 28th of December, 450 pots of the first lot were brought into a house which had a temperature of 40 to 45 degrees at night. All dead and diseased leaves were trimmed away. On the 6th of January, the young leaves had begun to appear freely and now and then there appeared a spot of the rust. They were then thoroughly sprayed with the ammoniacal carbonate of copper and after that time the disease made no trouble. The house was vaporized at frequent intervals with the Rose Leaf extract of tobacco in order to keep down insects.

Many flowers were open on the first of February. On the 9th, the pots were transferred to a warm house (temperature of 65 degrees at night), and the plants were staged near the glass, and were allowed to remain until the fruit was off (Fig. 73).

Upon the 6th of March, the berries were well colored, and the first picking was made on the 11th, when they sold in Ithaca for $2 per quart. The crop continued for about ten days.

The Beder Wood comprised the greater part of the pots of this first lot. They came into bloom when the foliage was still very small and scant, and we were fearful that there would not be foliage enough to carry the plants to maturity; but this fear proved to be groundless. It was observed that when the weather was very cloudy and damp, the stamens did not develop strongly and there was much difficulty in getting sufficient pollen to pollinate the flowers. The Beder Wood is a perfect-flowered berry, but we

found that it produced only sufficient pollen for itself. This pollen was transferred upon every bright day by means of a brush. A soft brush was rubbed over the anthers and the pollen thereby taken off, and then the brush was rubbed over the pistils (or the center of the flower). The operator always carried with him a little spoon-like implement, which is made by gluing a watch-crystal upon the end of a small ladle,* and whenever any flower contained a superabundance of pollen, the dust was shaken into this receptacle and used for those flowers in which the pollen was deficient. A common spoon would answer this purpose very well. It is necessary to repeat the pollinating every pleasant day. As in the case of tomatoes and other hot-house plants, the pollen is discharged most freely when the sun is warm and bright and when the house is dry. It is very essential that pains be taken to completely pollinate every flower, for if one side of the head of pistils is left unfertilized, that side of the berry will fail to develop and a nubbin will be the result.

Upon the 19th of February, when the berries were well set, liquid manure was first given to the plants ; and the application was repeated twice a week until the berries were about full grown.

It is necessary to devise some means to hold the berries up from the earth or the pot, otherwise they are likely to decay in the humid atmosphere of the house, and they become soiled in watering. Our first effort was to cover the tops of the pots with sphagnum moss, but two or three days of dull wet weather brought on indications of the rot, and the moss was quickly removed. Some of the pots were then covered with cork dust, such as is used in the packing of foreign grapes, and this answered the purpose most admirably ; but it is not always handy to get and it is some trouble to apply it and to keep it clean. The next attempt was the use of small pieces of fine wire screen, such as is shown in the illustrations, and this was a most admirable success. It kept the berries away from the earth and showed them off to the very best advantage. Forked sticks are sometimes used for this purpose.

The second lot of plants was brought in from the frames upon the 4th of February and placed upon a work-room floor where

* Figured in "The Forcing Book," Fig. 53.

the pots could gradually thaw out. Upon the 9th, they were placed upon the benches in a house with a temperature of 40-45 degrees at night, and thereafter they were treated in the same manner as those in the first lot. The third lot was handled in essentially the same way. In the second and third lots were a number of other varieties, of which the Sharpless and Van Deman were the most prominent. There were also a few Hunn. The best results were obtained with the Beder Wood, and this is the variety which is shown in Fig. 73 and also upon the title-page. One of its strong peculiarities is the comparatively small amount of foliage which it bears and the consequent greater prominence of the fruit. Its chief drawback is the light color of the berries. In respect to color, the Van Deman is somewhat better, but the habit of the plant is more tall and less attractive ; and although it is a perfect-flowered berry, we had difficulty in securing enough pollen to fertilize it. Its great merit for a forcing berry is its earliness. Sharpless is about ten days later than Van Deman, and Hunn is at least two weeks later. This last is the handsomest berry which we have had in the house, being very large and exceedingly dark colored ; but it is much too late to be profitable for forcing.

The first crop of Beder Wood averaged six first-class and uniform fruits to a plant in the whole lot of over four hundred pots. The plants set from eight to twelve berries each, but the small and imperfect ones were cut off and the limit was fixed at about eight fruits. We are now convinced that if we could have had stronger plants to start with, and with the experience of the present winter, we could average eight fruits to the plant. At this writing (April 23), the Beder Woods of the third lot are setting their fruits freely and no hand pollination is given them. The workman simply brushes his arm over the plants whenever he passes along, and the pollen seems to have disseminated itself freely. At this time of the year, however, the houses are open and dry so that the pollen is discharged much more freely than it is in the winter time.

Because the pots are set so close together in the house, it is possible to secure a larger yield per square foot under glass than is obtained in the field. In our experience, eight to twelve pots

give a quart of berries. That is, a quart is obtained from two to three square feet of floor space. Allowing for walks and unavoidable waste space, the yield would still figure up fully 400 bushels to the acre.

In regard to the demand for house-grown strawberries, we can give very little information. It is the province of an Experiment Station to determine how plants may be grown rather than to determine how they may be sold. In the larger cities, however, there is always a limited but brisk demand at high prices for winter-grown berries. The price ranges from four to even five dollars a quart down to two dollars and a dollar and a half. A well-grown pot of strawberries is one of the most interesting plants for table decoration and there is a considerable market for the plants in this condition. Late in April we saw six-inch pots of strawberries upon sale in a small city market for fifty cents each, none of which bore more than two or three ripe fruits, and even those were of very indifferent quality. With pots bearing from six to eight large and evenly ripened fruits, there should be no difficulty in realizing from one to two dollars a pot. The following note from *Garden and Forest* will bear out this statement:* "Pots of fruiting strawberry plants were an attractive Easter specialty in a fruiterer's window on Broadway last week. The foliage was fresh and luxuriant, with three or four large highly colored ripe berries and a few immature ones. The plants sold for $1.50 to $2.50 each."

In all our experience in the growing of plants, we have never aroused so much enthusiasm from plant lovers as with the strawberries; and it is difficult to conceive how any object can be better suited to the finest table decoration than a clean pot with a thrifty and well formed strawberry plant bearing six to eight full ripe berries and a few blossoms.

Some of the points in the cultivation of strawberries under glass which appeal to us with especial force are these:

1. Very strong plants to begin with, which have been kept in vigorous growth, and not allowed to become pot-bound until they have reached six-inch pots.

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* *Garden and Forest*, x. 160 (April 21, 1897).

2. Varieties which are early, or at least not later than midseason, and preferably those which themselves produce an abundance of pollen.

3. The exercise of great care to have the plants free of fungous diseases and insects before they are put upon the benches.

4. The devoting of an entire house to the crop. If two or three different crops are grown in the same house, none of them can receive the very best treatment which they demand ; and if there are other plants in the house which are infested with red spider, the pests will spread to the strawberries and it is very difficult to dislodge them without keeping the plants so wet that pollination is interfered with and rot threatened.

5. Growing the plants as close to the glass as possible.

6. In the dull months, constant and careful attention to hand pollination.

7. Liberal applications of liquid manure two or three times a week after the fruits have begun to swell.

8. Exercise of care that the berries do not lie directly upon the soil or upon a wet surface.

We are by no means confident that we have found the best methods of forcing strawberries. We give our experience for what it is worth, and desire to correspond with persons who can help us to better results.

C. E. HUNN.
L. H. BAILEY.

# Bulletins of Cornell University Agricultural Experiment Station,

1888 to Aug. 1, 1897.



* Out of Print.

Bulletin 135. May, 1897.

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

AGRICULTURAL DIVISION.

# Forage Crops.

By I. P. ROBERTS and L. A. CLINTON.

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1897

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135. Forage Crops.

# FORAGE CROPS.

There has within recent years been an increasing demand for information concerning forage crops. With many, meadows and pastures have proven insufficient to meet the demands made upon them and it has become a serious question as to the best manner for supplying the deficiency. The causes of the deficiency are various and far reaching but the results are the same. Especially in the dairy sections has the failure been most keenly felt and there has arisen a demand for information concerning forage and soiling crops.

Many successful farmers of the state who have practiced soiling, the growing of crops to be cut and fed green, have found the plan more satisfactory than depending entirely upon pastures, and the soiling system with them has become firmly established. Much of the land which has for years been devoted to permanent pasture or permanent meadow has ceased to be profitably productive, and where the tillage of such lands is practicable, ordinarily better returns would be secured were they devoted to the production of special forage crops. Short rotations and intensive agriculture must largely take the place of the permanent meadows and pastures where the land has been allowed to remain in sod year after year until the moss and the daisies have so taken possession that the fields looks more like huge flower beds than grass plats. Hardly a summer passes during which droughts more or less severe are not experienced. The effect of these droughts is always seen most quickly on the meadows and pastures and when this is observed there should be immediately available some forage crop which can be drawn upon to tide the stock over the dry time and give the pastures opportunity to recover. This is especially important in the dairy sections of the state where the milk supply should be kept up, no matter what the conditions of the weather. For the past few years the horn fly has been such a pest at times that some have adopted the practice of blanketing their cows to protect them

from the ravages of the fly. Unless protected in some way cows frequently fall off in milk production from fifty to seventy-five per cent. It is not only humane, but it is a wise financial policy to keep the cows stabled at least a portion of the day where it is shaded and cool, that they may be fed upon some freshly cut succulent forage provided for the purpose. Where cared for in this way they will usually respond abundantly and repay the extra labor involved.

That farm practice which necessitates that well bred animals designed for the production of milk should be compelled to work ten hours a day in order to get from the meagre pastures enough for a mere subsistence is radically wrong. A far better plan is to provide green forage so that during the hottest days the feeding may be done, at least in part, where the animals can eat with some degree of comfort and not be required to expend their energy in fighting the flies or in roaming over brown and parched pastures seeking for that green morsel which is not there and which the thoughtless owner has failed to provide.

Those crops which have proven themselves with us most successful as producers of forage are

Corn.
Oats and peas.
Oats.
Barley and oats.
Rye.
Barley.
Millets and Hungarian.

From the fact that so many queries are being constantly received with reference to the production of forage it has been thought wise to go somewhat into detail with the hope that the information given might prove of value.

## CORN AS A FORAGE CROP.

Where corn can be successfully grown it stands preëminent as a producer of forage and should have a prominent place in the rotation on every stock farm. Though some of the other crops mentioned later may serve better for early forage, yet for late summer or fall there is no crop which can compare with corn either in

amount of produce or feeding value. By the introduction of the silo it is now possible to produce milk as cheap or cheaper during the winter than during the summer. By the more general use of forage and soiling crops it will be possible to lessen materially the cost of production of milk in summer. Though corn is one of the most common of our farm crops, yet there are some facts with reference to its nature and production about which it may be well to speak somewhat in detail.

*History of the Plant.*

Corn is a sub-tropical plant and is supposed to have had its origin in Mexico. It loves a warm summer climate and a warm porous soil and grows to perfection only in the presence of sunlight and warmth. Corn is the richest gift of the new world to mankind, and even with the adverse conditions under which it is so often raised its value in America far exceeds that of any other crop grown.

*Soil for Corn.*

Owing to the sub-tropical nature of the plant, that soil is best suited for the growth of corn which is well drained, loose and fairly porous but not leachy. A loamy soil with a clay subsoil presents almost ideal conditions. The plowing should be so done that the soil is well pulverized and the furrow slice left somewhat on edge, not completely inverted. Where sod land is plowed the jointer attachment should always be used that the tenacity of the sod may be broken up. The placing of the furrow upon edge and allowing it to remain for a few days before harrowing down gives chance for aeration and warming, both of which are prime requisites for success in corn raising. While a fairly fine seed bed is important, yet only so much harrowing as is necessary to produce it should be given. In fitting the land for wheat the sub-surface soil may be somewhat firmly compacted. A firm, compact sub-surface soil and a loose surface mulch present the ideal conditions for wheat, and the tramping and packing of the horses feet may do as much or more good than the harrowing. But with corn different soil conditions are required, and unless necessary in order to improve the texture of the soil, the fitting should be somewhat superficial, for if much harrowing be done, this, with

the packing which the soil must receive in after tillage, will so compact the sub-surface soil that harmful conditions will be produced.

*Planting of Corn for Forage and the Silo.*

When the silo first came into general use it was believed that the corn with which to fill it should be planted thickly either in hills or drills and that the quality of the produce was in no way depreciated in value by being grown thickly. A too common practice now is to raise sowed corn, the claim being that it produces a larger amount of forage per acre and that though planted so thickly that no ears can form and mature, yet the valuable food constituents which would go into the ears if formed, in this case go into the stalks. Some of the most observing farmers have noticed that sowed corn is quickly affected by drought, that before growth is half complete the lower leaves are usually parched and burned. There are so many plants growing on the soil that the moisture supply is entirely inadequate to meet the demands being made upon it. As has been mentioned, corn is a sun plant and grow to perfection only when the sunlight permeates to every part of its structure and corn grown largely in the shade as is sowed corn, though it may produce a large gross amount, yet the product is deficient in those volatile oils which so largely determine the quality of the food. The protein, the most valuable constituent, is deficient as will be seen by reference to the table giving the analysis of corn.

During 1895 and 1896 experiments were conducted to determine the relative feed value of corn planted in hills, drills and sown broadcast. The variety of corn used was Sibley's Pride of the North. The soil was gravelly loam and had been for years subjected to a four years' rotation, consisting of wheat, meadow (clover and timothy), corn and oats. During the winter of 1892-4 the land was given a top dressing of stable manure, about ten tons per acre. In the spring of 1894 the land was fitted, and planted to corn. After the corn was removed the land was plowed in the fall and gang plowed in the spring and the three one twentieth acre plats to be compared were planted May 2 and 3, 1895 to Sibley's Pride of the North. Plat 31 was planted in rows 3¼ feet apart with hills 3½ feet apart in the row and 4 kernels to the

hill. Plat 32 was drilled in with a common grain drill, so arranged that the rows were 3½ feet apart while the broadcast conditions were obtained by drilling in the corn with all hose of the drill open and sowing at the rate of two bushels per acre. The yield from the various plats is shown in the following table :

TABLE SHOWING RESULTS FROM DIFFERENT METHODS OF PLANTING CORN, 1895.

| Plat No. | Manner of planting. | Yield per acre. Pounds. | | |
|---|---|---|---|---|
| | | Stalks. | Grain. | Total. |
| 31 | Hills. | 15,340 | 6,000 | 21,340 |
| 32 | Drills. | 20,240 | 6,400 | 26,640 |
| 33 | Broadcast. | 29,580 | 00 | 29,580 |

In 1896 the corn was planted similar to the way in which it was planted in 1895.

TABLE SHOWING RESULTS FROM DIFFERENT METHODS OF PLANTING CORN, 1896.

| Plat No. | Manner of planting. | Yield per acre. Pounds. | | |
|---|---|---|---|---|
| | | Stalks. | Grain. | Total. |
| 22 | Hills. | 18,800 | 5,280 | 24,080 |
| 23 | Drills. | 19,390 | 2,304 | 21,094 |
| 24 | Broadcast. | 29,591 | 00 | 29,591 |

If the investigation had stopped here the results would clearly have been in favor of the broadcast method of seeding. This is as far as the producer is able to get unless he is of an especially enquiring mind and conducts careful feeding experiments with an endeavor to find out from the animal which material is best. At the time the corn was in best condition for forage, samples were taken from each plat. On the plats of hilled and drilled corn the

sample included the stalk and the grain, while of necessity the sample from the plat of sowed corn was only of the stalk, there being little or no grain formed. Care was taken to have the sample from each plat a good average of the produce of the plat. The analysis was made from the 1895 crop and assumed to fairly represent the crop of 1896 grown under similar conditions.

The following table shows the average yield from the plats for the two years and the estimated food value of each product, the computations being made from the analysis of the 1895 crop.

A careful study of the table will reveal several things, which without the aid of the chemist might have passed unnoticed. While the plat of broadcast corn gave the greatest total yield per acre yet little or no grain was formed and the feed value was relatively less than on the plat of corn planted in hills. Though the column giving the estimated value per acre does not necessarily represent the true feeding value yet it does correctly represent the relative value. If the analyses had been carried still farther and the proportion of digestible nutrients determined there is but little question that a wider difference would have been shown in the actual feed value. Could the animal have been questioned as to which method of planting furnished the best fodder she would have spoken in unmistakable terms in favor of that corn which was grown in the open sunlight.

The following quotation from Bulletin 16, Cornell Experiment Station, may be found helpful to an understanding of the tables.

" It seems still necessary that an explanation of the terms used should accompany all discussions of foods and fodders, and we may therefore be pardoned for repeating it here.

The value of a fodder in the main depends upon the amount and relative proportions of four classes of constituents. These are usually denominated by chemists as crude protein (nitrogen multiplied by 6.25), ether extract, nitrogen-free extract, and fibre.

*Protein* is the most costly and the most valuable constituent of fodders. Protein substances contain nitrogen and are often called albuminoids or flesh formers. They are found in all parts of all plants and all animals, and are important and indispensable con-

## CORN AVERAGE.*

RESULTS FROM DIFFERENT METHODS OF SEEDING FOR 1895 AND 1896.

| Manner of planting. | Yield per acre. | | | Analysis. | | | | | | | Estimated value per acre. † |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stalks. | Grain. | Total. | Moisture. | Dry matter. | Protein. | Fat or ether extract. | Nitrogen-free extract. | Fibre. | Ash. | |
| | Pounds. | Pounds. | Pounds. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | |
| Hills............. | 17,070 | 5,648 | 22,718 | 68.67 | 31.33 | 2.83 | .88 | 19.92 | 6.42 | 1.28 | $73.31 |
| Drilled.......... | 19,815 | 4,384 | 24,199 | 71.16 | 28.84 | 1.83 | .68 | 18.13 | 6.94 | 1.26 | $66.83 |
| Broadcast......... | 29,586 | None | 29,586 | 76.42 | 23.58 | 1.38 | .60 | 14.04 | 6.37 | 1.19 | $68.17 |

* The chemical work of this bulletin was done by Mr. Geo. W. Cavanaugh. The details of the field work in 1895 were conducted by Mr. Geo. C. Watson.

† Protein 2.3 cents per lb.; fat 1.14 cents per lb.; nitrogen-free extract and fibre 94 cents per lb.—*Conn. Exp. Station, 1893.*

stituents of lean meat, blood, and all internal organs. Since a large number of fodders are lacking in this class of constituents, the amount of protein that a fodder contains is largely a measure of its value.

*Ether extract* is mainly composed of fats and oils, and is usually spoken of as such. It is used by the animal as a heat producer or stored up in the tissues of the body as surplus fat. For these purposes it is worth nearly two and one-quarter times as much as starch, sugar, gum, and other carbhydrates.

*Nitrogen-free extract* consists of those substances containing no nitrogen that are soluble in water and dilute acids and alkalies; it is mainly made up of starch, sugar, and gum, and the whole class is often spoken of as carbhydrates. The functions of these carbhydrates in the animal economy is mainly that of heat and fat producers.

*Fibre* is that portion of the plant not dissolved by the action of dilute acids and alkalies. In composition it is a carbhydrate, and its function as a fodder is the same as the other carbhydrates, but being less digestible is of less value."

A most important element which enters into determining the feeding value of corn is the degree of maturity it reaches before being cut. It increases in value very rapidly as it approaches the period of maturity. In the case of corn planted in hills so that it can be given tillage the moisture may be conserved even during drought so that the corn is enabled to continue growth until it reaches maturity and posesses its greatest feeding value. With the sowed corn conditions are entirely different, for long before the time of maturity the corn has ceased growth because the moisture supply has been used up. In 1896 the corn on the broadcast plat was dry and parched ready for cutting August 14th. Before cutting the plat two rows were cut from the outside where the sunlight and moisture had been more abundant. The weight of the forage from the two rows was 330 pounds. On the same date two rows were cut through the center of the plat where sunlight had been excluded and moisture deficient and the total weight of the forage from the two rows was only 81 pounds. The whole plat of broadcast corn was cut August 14th in order to save it. The adjoining plat of drilled corn was suffering from drought and

was cut August 21. The adjoining plat of hilled corn showed no signs of wilting and continued its growth and development until time of cutting September 8th.

74.—*A corner of a Plat of Sowed Corn.*

The very rapid increase in feeding value of corn as it approaches maturity should be understood all by producers whether the product is to be used for silage or fodder. The importance of the subject leads us to republish a portion of Bulletin 16 of this Station in which the matter is clearly set forth.

*The best period for cutting.*

"As the results of analyses made at different periods of growth

in 1888 we strongly urged* that only such varieties of corn should be grown for ensilage as would reach a good degree of maturity in the locality grown. These conclusions have been abundantly confirmed, not only by our own experiments repeated in 1889, but by similar experiments at several other stations.

The variety used was the same as last year, viz.: Pride of the North of a strain that has been grown on the farm for several years and has become well acclimated. The soil was a clayey loam. It was in clover and timothy sod and had received a good dressing of farm-yard manure during the winter. The corn was planted in hills three feet three inches by three feet eight inches apart, and received ordinary cultivation.

The season was late and very wet. The corn was planted about May 12, and the first cutting was made on August 2, at which time it was just coming into blossom and was at the same degree of maturity, as well as could be judged, that it was in 1888 on July 24th. On Aug. 17th the second cutting was made, the kernels were just beginning to fill with milk. The corn matured much more slowly in 1888 than in 1889, and further cuttings were made on Aug. 31st and Sept. 10th, during the period of "roasting ear" condition. The final cutting of the mature corn was made on Sept. 24th, no frost having intervened. The corn at this cutting was perhaps a trifle more mature than it was in 1888 on Sept. 3.

The samples were taken as follows: At each cutting three average hills were selected and cut close to the ground. They were then treated in the same manner as the samples of the different varieties already described. The table below shows the percentage composition at the various periods. It will be noticed that the most marked difference is in the great increase in dry substance between Sept. 10th and Sept. 24th. It will also be noticed that there was more water on Aug. 17th than on Aug. 2d. This is entirely out of the usual experience and may perhaps be due to the individuality of the plants sampled. In regard to the dry substance we find, as is usual, that the per cent of protein gradually diminishes and of carbhydrates and fibre increases as development approaches maturity.

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*Bulletin No. 4. Cornell University Agricultural Experiment Station, p. 52.

TABLE IV.

| DATE OF CUTTING. | STAGE OF MATURITY. | Water Per Cent. | Dry Matter Per Cent. | IN THE DRY MATTER. Crude Protein Per Cent. | Ether Extract (fat) Per Cent. | Nitrogen-Free Extract (carbhydrates) Per Cent. | Crude Fibre Per Cent. | Ash Per Cent. |
|---|---|---|---|---|---|---|---|---|
| Aug. 2...... | In Bloom. | 85.25 | 14.75 | 9.87 | 2.68 | 58.07 | 22.06 | 7.32 |
| Aug. 17.... | In Milk. | 87.31 | 13.69 | 9.03 | 1.71 | 57.74 | 25.11 | 6.41 |
| Aug. 31.... | Roasting Ear. | 82.56 | 17.44 | 8.84 | 1.96 | 55.21 | 28.43 | 5.56 |
| Sept. 10.... | Roasting Ear. | 81.37 | 18.63 | 6.17 | 2.43 | 59.06 | 27.19 | 5.15 |
| Sept. 24 .. | Mature. | 69.75 | 30.25 | 7.53 | 2.46 | 61.46 | 25.05 | 3.50 |

At each period of cutting, except the last, besides taking the sample, there were cut and weighed sixty hills of corn. The weight of the corn so cut was used as a basis for computing the yield of green fodder and of the various constituents per acre, except in the cutting of Sept. 24, when a measured acre was cut and weighed. These results are shown in the table below.

TABLE V.

| DATE OF CUTTING. | STAGE OF MATURITY. | YIELD IN POUNDS PER ACRE. Green Forage. | Per Cent. Water. | Dry Matter. | Crude Protein. | Ether Extract. | Nitrogen Free Extract. | Crude Fibre. | Ash. |
|---|---|---|---|---|---|---|---|---|---|
| Aug. 2....... | In Bloom. | 24805 | 85.25 | 3658 | 361 | 98 | 2124 | 807 | 268 |
| Aug. 17..... | In Milk. | 27830 | 87.31 | 3810 | 344 | 65 | 2200 | 957 | 244 |
| Aug. 31..... | Roasting Ear. | 30250 | 82.56 | 5274 | 467 | 103 | 2912 | 1499 | 293 |
| Sept. 10..... | Roasting Ear. | 28980 | 81.37 | 5398 | 333 | 133 | 3188 | 1466 | 278 |
| Sept. 24..... | Mature. | 30108 | 69.75 | 9109 | 686 | 224 | 5598 | 2282 | 319 |

It will be seen that between the first and last cutting the dry matter and carbhydrates increased about 150 per cent, the fat about 125 per cent and the protein nearly doubled. In our experiments last year* we found that the total feeding value, in the period between tasseling and ripening, increased 166 per cent, so that the experiments of this year confirm those of last.

Further than this, investigations at three other experiment stations have been made in almost exactly the same way and the results of all agree. These experiments in brief are as follows:

In 1887 Professor Whitcher, of the New Hampshire Agricultural Experiment Station, made analyses of four different varieties at four stages of growth.† The four varieties were a southern ensilage corn, a northern flint corn, Sanford (flint), and Pride of the North (dent). The cuttings were made July 26, Aug. 5, Aug. 19, and Sept. 16. At the first date none were in tassel but the northern flint; at the last date the northern flint was completely ripe, the Sanford and Pride of the North were nearly mature, and the kernels of the southern ensilage were just blistering. Between Aug. 5th, at which time but one of the varieties had passed the blossoming stage, and Sept. 16th, there was an increase in dry matter of 112 per cent, in albumenoids of 50 per cent, in fat of 84 per cent, and in carbhydrates of 130 per cent.

In 1888, at the Pennsylvania Agricultural Experiment Station, Mr. Caldwell found‡ that between the period of tasseling and complete ripeness there was an average gain of dry matter of 155 per cent. Ten varieties of corn (dents and southern ensilage corn) were used. Only the dry matter was determined. The dates of cutting are not given, and the last determination was made from the ears and stover cut and shocked as for grain.

In 1889, at the New York Agricultural Experiment Station, a very thorough investigation of this subject was made by Mr. Ladd, chemist of the station.|| The variety used was King Philip; the dates of cutting were July 30, Aug. 9, Aug. 21, Sept. 7, and Sept. 23, at which dates the condition of maturity was, re-

* Cornell University Agricultural Experiment Station Bull. 4. p. 52.

† New Hampshire Agricultural Experiment Station Bull. No. 3.

‡ Pennsylvania Agricultural Experiment Station Bull. 7, p. 7

|| New York Agricultural Experiment Station 8th Ann. Rept. p. 86.

spectively, tasseled, silk, in milk, glazed, and ripe. The computations were in each case based of the yield on a plot of a fifth of an acre so taken as to represent the average of a field of twelve acres. Between the first and last period there was an increase in dry matter of 389 per cent, of albumenoids of 183 per cent, of fat of 335 per cent, and of carbhydrates of 462 per cent.

In the above only the gain between the first and last periods is given, but the details show that the gain is continuous from period to period, and in general most rapid toward the last.

The results of all these experiments unite to show that there is a large increase of all the classes of nutrients as the corn proceeds from tasseling to ripeness.

It would seem as though the question of the proper time to cut corn for ensilage was definitely settled by these experiments. An increase of more than two hundred per cent between the periods of bloom and ripening cannot be ignored even though the proportion of the more valuable albumenoids is somewhat lessened. What gives the matter additional strength is that these experiments, including all the work so far done in this direction that has come to our notice, are unanimous in their conclusions."

The conclusions reached in the bulletin just quoted have in no way been disproven but have been amply confirmed by later experiments of this and other stations.

## OATS AND PEAS AS FORAGE.

Ranking next to corn as a forage crop and a close second, comes oats and peas. In the two years in which we have been conducting experiments in the production of forage this combination has proven itself well worthy of a place on every farm where stock is kept. It is valuable either for pasture, for cutting as a soiling crop, or when allowed to mature it may be cured for hay, making a most valuable article. When planted in succession of about two weeks, the first planting being as early in the spring as conditions will permit, a succession of highly nutritious forage is produced which is greatly relished by stock. If a more general use was made of oats and peas for summer feeding it would

greatly decrease the expense of the production of milk and the cost of maintaining cattle and economize land very materially. A highly nutritious forage would be obtained, rich in protein and furnishing nearly a balanced ration for milch cows. A large amount can be produced per acre and it may be grown from early spring to late fall. A slight freeze does not affect it, and it may be sown in the spring before frosts are over and the late forage frequently remains in good condition until December. The oats and peas at this station sown August 1st, 1896, were in good condition for feeding until a severe freeze on the night of December 2d cut them down. For late forage, however, barley and peas are recommended instead of oats and peas. For sowing any time after July 1st substitute barley for oats. The reason for this is that in late summer barley makes more rapid growth, is less likely to attacks of rust and other fungous diseases than are oats. Figure 77 shows the relative growth of oats and barley in late summer, the tall plants being barley the shorter ones oats, seed for which was sown August 1st and photograph taken in late October.

*Preparation of Soil for Oats and Peas.*

This crop loves a mellow, loamy soil but will grow fairly well on soils ranging between heavy clay and sand and produce liberal returns. For early forage land should be selected which is moderately open and porous so that the plowing may be done early. Those soils containing a comparatively large percentage of clay can better be used where late forage is desired. Land should be plowed deep and in cases where sod is inverted the jointer should be used.

*Method of Seeding.*

While the land is still rough as left by the plow the peas should be sown broadcast at the rate of about one bushel per acre. Then the harrow should be used and the land thoroughly fitted and fined for oats. This fitting will cover the peas deeply and well, and it is to secure this deep covering that the peas are sown directly after the plow. Oats may then be sown broadcast or drilled in the ordinary way, using one bushel to one and a half bushels of seed per acre If the soil is somewhat porous, sandy or gravelly, the

roller may follow the seeding. But should there be a somewhat large per cent of clay in the soil then the rolling would better be deferred until the young plants are two or three inches high, when the roller can be used without danger of producing injurious soil conditions due to packing. In six to eight weeks from time of sowing, with favorable conditions, cutting may begin though the greatest feed value is not reached until the time the grain is well in the milk stage. The commencement of cutting, however, should not be delayed until that time for, if there is any considerable area to be fed, the forage will have become too hard and woody before all of it can be used to advantage. Commence cutting or pasturing at or before the time of blossoming and continue through the milk stage. If the area is greater than can be advantageously used for forage and it is desired to cure a portion of it for hay, then the cutting should be done when well in the milk stage. It makes such a heavy growth and contains such a large percentage of water that some difficulty is occasionally experienced in the curing.

In our efforts to determine the relative value of some of the more common forage crops an experiment has been conducted for two years, during 1895 and 1896. In 1894 a crop of corn was grown on the land which had received during the previous winter a small dressing of barn manure. The size of plats was one-twentieth of an acre. At the time the grain was in the best apparent condition for forage, one-half of each plat was cut and weighed and a sample taken and analyzed. The other half was allowed to mature the grain, when it was cut and threshed, and the weight of grain and straw determined. The feeding value of the forage was determined from the sample taken when the first one-half of the plat was cut and all results as to yield and value are calculated per acre.

75.—*View of Plats, one-half of each plat has been cut for forage.*

PRODUCTION OF FORAGE 1895. ALL PLATS SOWN APRIL 24.

| Plat No. | Grain sown. | Date of cutting forage. | Weight of forage per acre. | Date of cutting ripe grain. | Amount of grain per acre. Bushels | Weight of straw per acre. |
|---|---|---|---|---|---|---|
| 42 | Oats and peas | July 16 | 21,600 | Aug. 3 | 85 | 5,280 |
| 43 | Oats and barley | July 5 | 16,800 | Aug. 3 | 82.5 | 3,760 |
| 44 | Barley | June 29 | 11,600 | July 23 | 55.6 | 4,080 |
| 45 | Oats. | July 11 | 10,480 | Aug. 3 | 50.6 | 3,580 |

PRODUCTION OF FORAGE 1896. ALL PLATS SOWN APRIL 20.

| Plat No. | Grain sown. | Date of cutting forage. | Weight of forage per acre. | Date of cutting ripe grain. | Amount of grain per acre. Bushels. | Weight of straw per acre. |
|---|---|---|---|---|---|---|
| 35 | Oats, Am. Banner | June 30 | 14,080 | July 22 | 56 | 4,200 |
| 36 | Oats and barley | June 30 | 11,200 | July 22 | 65 | 3,400 |
| 37 | Oats and peas | July 1 | 26,000 | July 22 | 49 | 2,360 |
| 38 | Oats, White Russ'n | June 30 | 15,200 | July 22 | 72.5 | 3,680 |
| 39 | Oats, White Russ'n | June 30 | 17,080 | July 22 | 78.75 | 3,480 |
| 40 | Oats, Am. Banner | June 30 | 16,080 | July 22 | 97.5 | 4,880 |
| 41 | Oats, Silver Mine | June 30 | 19,320 | July 22 | 90 | 3,920 |
| 42 | Oats and peas | July 2 | 26,000 | July 22 | 43.5 | 4,400 |
| 43 | Oats and barley | June 27 | 18,000 | July 22 | 60 | 5,400 |
| 44 | Barley | June 22 | 15,200 | July 22 | 50 | 3,600 |
| 45 | Oats, White Russ'n | July 1 | 19,200 | July 22 | 52.5 | 5,320 |

FORAGE CROPS.

*Average Results 1895 and 1896. Calculated from the Analyses of forage made of 1895 Crop.*

| Crop planted. | Average yield per acre. | Mois-ture. | Dry matter. | Analysis of dry matter. Protein | Fat. | Nitro-gen-free ex tract. | Fibre. | Ash. | Estimated value per acre calculated on dry matter.* |
|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | |
| Oats and peas. | 24,336 | 75.99 | 24.01 | 16.58 | 4.21 | 41.67 | 27.75 | 9.79 | $63.11 |
| Oats. | 16,826 | 65.40 | 34.60 | 9.36 | 4.80 | 46.30 | 30.95 | 8.58 | 57.99 |
| Barley and oats | 15,333 | 65.59 | 34.41 | 10.14 | 4.36 | 49.28 | 28.92 | 7.30 | 43.39 |
| Barley | 13,400 | 77.01 | 22.99 | 11.33 | 2.07 | 50.32 | 29.92 | 6.36 | 31.99 |

* Protein 2.3 c. lb.; fat 1.14 c. lb.; nitrogen free; extract fibre .94.—*Conn. Exp. Sta. 1893.*

A careful study of the preceding tables will reveal several things. Though the estimated values given do not necessarily represent the actual feeding value, yet they do fairly show the relative value of the different crops for the production of forage. The unit of value used for the different constituents while not necessarily representing their value for all sections, does fairly represent their value for this state. The oats and peas are relatively rich in protein and ash elements. The protein is the most costly constituent which the New York feeder is called upon to provide, and it is this constituent which is most likely to be deficient in the ration. The ash constituent of a fodder is usually passed over without any comment, it being taken for granted that all fodders contain enough to meet the demands of the animal economy. But this conclusion is not based upon fact. The ash element of the fodder enters into the building up of the frame work of the body, the skeleton, and it is of the utmost importance that the mineral or ash material be present in liberal quantities. Oats and peas furnish a larger percentage of ash than any of the other forage crops grown by us and the importance of this, while not definitely known, is real and should not be overlooked.

76.—*Oat Field at Cornell University. Back part of Field being filled for Wheat.*

A comparison of the tables showing the feeding value of corn and forage crops shows that of all varieties tested, corn is in the lead and that oats and peas come second. For variety of feed it would probably be advisable to have some plats of barley or of oats and barley combined, but the greatest returns with us were secured from corn and from oats and peas sown broadcast.

## BARLEY AND PEAS.

While oats and peas are recommended for early forage, yet for late forage barley should be substituted for the oats. Figure 72 shows the relative growth of barley and oats in late fall. On August 1 the plats on which the forage crops were grown were all seeded to oats and peas. The volunteer barley which came up on the plats where barley had been grown grew much faster than the oats and was less affected by rust and drought.

Figure 78 shows the corner of a plat of oats and peas which was sown August 15. This was the third crop which had been grown on the ground during the season. Wheat which had been sown the previous fall was cut for forage when the grain was in the milk stage. The ground was then immediately plowed and sown to Hungarian grass on June 29. On August 11 the Hungarian was cut, producing five and one-half tons of green forage per acre. The ground was immediately plowed and on August 15 sown to oats and peas which were photographed in late October. They remained in good condition for forage until December 2.

Rye as a forage crop has to recommend it the fact that it is available for early spring use. As a cover crop it is becoming more general and for this purpose it is valuable. The land on which corn or potatoes have been grown should not be allowed to go into winter without some cover crop. Rye serves this purpose well and where so used it can be made to serve the double purpose of a cover crop and an early spring forage crop. After removing the rye in the spring the land may be utilized for the production of forage from oats and peas or for other crops.

## HUNGARIAN AND MILLETS.

There are probably no crops grown for forage or for hay about which there are more inquiries than the Hungarian grass and the

77.—*Showing the relative growth of Barley and Oats for late forage.*

78.—*Plat of Oats and Peas grown for late forage.*

millets. No doubt they would be more extensively grown were their value and uses well understood. They are not recommended as being valuable as a part of the regular rotation, but as catch crops or special crops they have their place. They are very depleting to the soil and many have had unsatisfactory experience in feeding them to stock. Every farmer should have a knowledge of the proper use of the millets and of their place in the farm economy.

Hungarian grass is in most common u e in the east, while in the west common millet and in the south German millet are more popular. One value of millet lies in the fact that it can be sown late, in fact must not be sown until all danger from frost is over. It develops rapidly and during midsummer is ready to begin cutting for forage about thirty days from time of seeding. The Hungarian is quicker maturing than the millets and for late sowing is preferable to either the common or the German millet. In such a year as 1894 or 1895, when many farmers found their hay crop a disappointment and were at a loss to know how to supplement it, Hungarian or millet would possibly have served the purpose well.

The soil should be rich and given thorough preparation. Clay soils which are inclined to be lumpy require extra precaution in fitting. The amount of seed required varies from one-half bushel to three pecks per acre, which should be harrowed in lightly and rolled. On freshly cleared or bottom-land soils it makes a rank growth and is available for forage at a time when it is usually found necessary to supplement the pastures. Though it is a gross feeder yet this fact may be of actual benefit to the kinds of soil just mentioned.

*Feeding millet green.*

When stock is turned in upon a field of green millet for the first time, or a heavy feed is given, there is danger that serious results may follow. Animals not accustomed to green forage should not at first be allowed a full feed of any green crop, especially millet, but should be given only a part ration of the green material. If allowed to gorge themselves serious results may follow. If it is desired that the animals be turned upon the crop to pasture this should be done only after their appetite has been partly appeased by other food.

Millet hay is not in popular favor owing to the fatal results which, in some cases, have followed its use. Just why these unsatisfactory results sometimes follow does not seem to be clear. In feeding it to horses caution should be observed and the millet hay used in conjunction with some other coarse fodder. Much of the value of millet hay seems to depend upon the time of cutting, which should be done soon after blossoming.

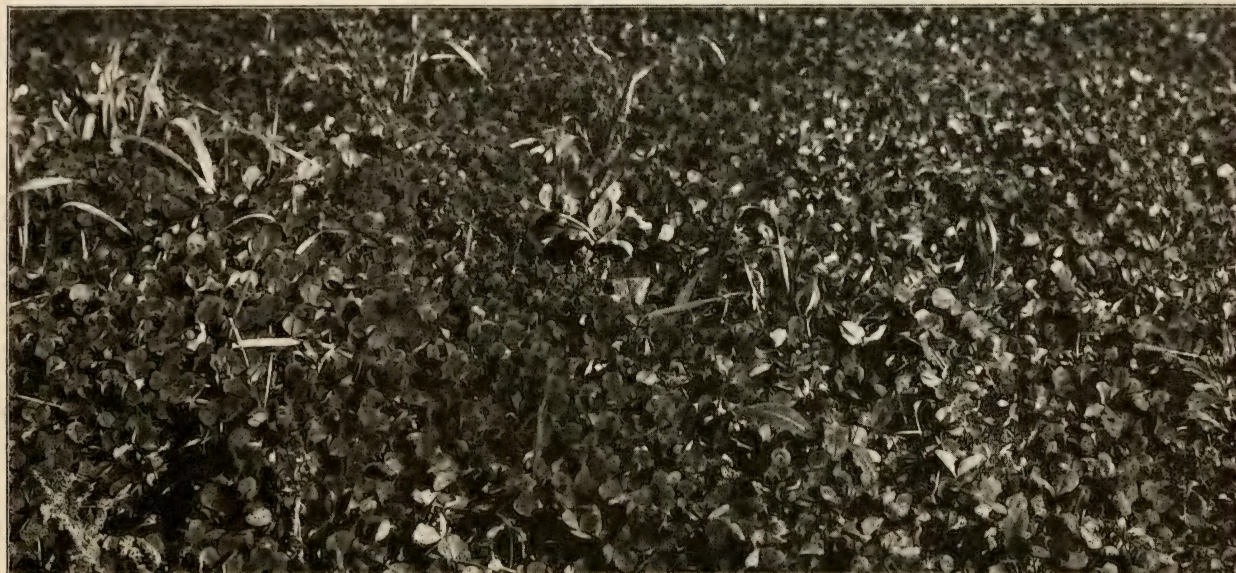
## SORGHUM, TEOSINTE, SACALINE, ETC.

These crops are mentioned in this bulletin only for the fact that many inquiries are received asking about their merits for this section. While sorghum seems to possess some value, yet for forage, corn is so far superior, when all things are considered, that where it can be raised sorghum is not a necessity in the rotation. It seems to possess its chief value in the fact that it is able to withstand drought and grow under conditions where corn would be a failure. So far as our experiments with teosinte and sacaline go we cannot recommend them for general use. Though they may possess value for certain localities, yet in New York there are so many crops which can be successfully grown for forage that the farmers should be slow to adopt the new varieties except by way of experiment until they have been tested and proven of value.

## CRIMSON CLOVER.

Figure 79 shows a plat of crimson clover, the seed for which was sown August 1, the photograph being taken late in October. This clover was growing on land from which a forage crop of oats and peas had been cut. There has been much discussion at Farmers' Institutes and in the columns of the Agricultural press as to the value of crimson clover in this state, as a forage crop and as an improver of the soil. To answer these questions in part and to determine the relative value of the different clovers there were planted side by side on August 1, 1896, three plats of clover, one of crimson, one of common red and one of mammoth. The soil were gravelly and porous. All varieties of clover came up quickly and made good growth. The crimson clover, however, made far more rapid growth in the fall than did the others.

One object of these experiments was to determine the amount



79.—*Plat of Crimson Clover.*

of nitrogen stored up by the different varieties of clover. On November 2, samples were taken of each kind of clover, the roots and tops of each being taken as the sample. The chemical analysis shows the following amount of nitrogen stored up in each per acre.

| Variety of clover. | Nitrogen in tops (pounds). | Nitrogen in roots (pounds). | Total pounds of nitrogen per acre. |
|---|---|---|---|
| Crimson............ | 125.28 | 30.66 | 155.94 |
| Red................ | 63.11 | 40.25 | 103.36 |
| Mammoth ........ | 67.57 | 78.39 | 145.96 |

All clovers wintered well, but in the spring the freezing and thawing killed nearly all of the crimson clover. It had, however, served its purpose as a cover crop and for late fall pasture would have been valuable, leaving in the ground enough fertilizing material to pay for the expense of the seeding.

## SUMMARY.

1. Some provision should be made on every stock farm for forage and soiling crops.

2. The most valuable crop for the production of late forage is corn, and corn planted in hills is more valuable for feeding purposes that when drilled or sown broadcast.

3. Oats and peas are second in value to corn for the production of forage. For late forage barley and peas are recommended.

4. Millets are valuable and when fed properly may be used without danger.

5. Crimson clover proved valuable for late fall pasture and as a cover crop. Its greatest value with us was from the fact of its storing up nitrogen so abundantly.

I. P. ROBERTS.
L. A. CLINTON.

Bulletin 136. May, 1897.

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

HORTICULTURAL DIVISION.

# CHRYSANTHEMUMS

OF 1896.



By L. H. BAILEY and WILHELM MILLER.

PUBLISHED BY THE UNIVERSITY,
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In pursuance of the provisions of Chapter 128 of the Laws of 1897, the following persons have been appointed investigators and instructors in the College of Agriculture of Cornell University to serve throughout the state according to the needs of the several localities for a portion or all of the year.

| | | |
|---|---|---|
| J. W. SPENCER, | M. V. SLINGERLAND, | A. L. KNISLEY, |
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The regular bulletins of the Station are sent free to all who request them.

## BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk about Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums.
132. Notes upon Celery.
133. The Army-Worm in New York.
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135. Forage Crops.
136. Chrysanthemums of 1896.

CORNELL UNIVERSITY, ITHACA, May 10, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY,

*Sir:*—The following bulletin from the Horticultural Divison is a part of the work which was planned under the Nixon Bill for last year. For two or three years considerable work has been done by this station in floriculture, with the object of helping both florists and flower-lovers everywhere. The bulletins have awakened much interest and have, undoubtedly, done much good in calling attention to a branch of agriculture which has heretofore received little consideration from the public institutions of the country. The work has been done with the greatest care and deliberation, and the bulletin is submitted for publication under Chapter 128 of the laws of 1897.

I. P. ROBERTS, Director.

## I. GENERAL REMARKS. (*L. H. Bailey.*)

For three years we have made a special effort to study the problems associated with the florists' chrysanthemums, and this is the third report which we have published upon the work. Our object in this, as in all floricultural study, is to help both the general flower-lover and the professional florist, and we cannot, therefore, devote our attention wholly to amateur methods upon the one hand, nor to the raising of exhibition blooms upon the other.

We stand for the buyer as well as for the seller ; and the question therefore at once arises as to what the real measure of a variety is. Is one bloom, or one vase of blooms, chosen from a score or a hundred or a thousand plants which have received the utmost care and forcing, to be taken as the ideal of the variety? It is the fashion to describe varieties of florists' plants from just such blooms,—from those which draw the prizes in the exhibitions. But since there are few persons who can give this extra care and skill to the growing of a few plants, even if they cared to do so, and since only a part (and often a small part) of any number of plants can be expected to give such results, even under extra treatment, it is easy to see why the novelties are so often a disappointment to the buyer. The fact is, that the highly forced and extra-selected exhibition flower is not always the true measure of what a variety is, but is a measure of what may be done with a few plants. The true type or measure of any variety is the composite character which a whole patch gives, under good care. The flower show is of the greatest value as a popular educator and as a source of information and inspiration to the plant-breeder, but it is not the place in which the general flower-grower should expect to see what a variety actually is. It is often possible to select a few most meritorious exhibition blooms from a range of plants of an inferior variety.

If these points are well taken, then it follows that an experiment station, when reporting upon the merits of varieties, should

aim to present a true composite picture of what the variety is when grown under good and fair conditions. If the station exhibits, its province seems to lie in the same direction. At all events, the writer will never consent to make an exhibit of varieties from the station unless he can show everything, good and bad alike. This is not saying that he disparages the display of exhibition blooms by a station, but in such cases the exhibition is to show cultural methods, not to show varieties. If a station desires to test the varieties of any plant, it exceeds its aim when it endeavors to see how much it can improve those varieties by forceful culture ; for the purpose is to find out what the varieties are, not what they may be compelled to be. And even if the experimenter were to desire to force every variety to the exhibition standard, he could not do so with several hundred varieties ; and to force one and not another would be anything but truthfulness. These remarks seem to be necessary in order to place the subject of variety-testing in its true light, and to let florists see why it is that our descriptions of varieties are sometimes so unlike the descriptions in catalogues.

Another feature of the subject needs also to be touched upon. We said upon a former occasion that we do not always receive the best stock which dealers have. By this we mean that we believe that the ordinary run of commercial stock is commonly received, whilst the exhibition blooms at the flower shows are preferably grown from extra-good stock, which, in many cases, is not for sale. It is no doubt better that an experiment station should receive this commercial stock, for it thereby arrives at a more truthful conclusion as to the actual merits of the variety. In some cases we have received plants which are so poor that no fair and true idea of the variety can be obtained from them ; and from such stock, and from that which may have received inadequate attention on our own part, we intend never to publish results. These remarks are made for the sole purpose of emphasizing the fact that the quality of the stock,—as respects vigor, healthfulness, early propagation, and the like,—is of the utmost importance in the growing of any plant, and particularly of florists' flowers. To bring the subject home, we have inserted a picture (Fig. 82, page 308) showing the variation with which

we often have to contend in the testing of plants. The two plants at the left are fit to produce excellent flowers (though not trained for the production of exhibition blooms) whilst those at the right are plants which are expected to be compared with them. The past season it was so necessary to give forceful culture,—by very heavy fertilizing,—to bring some of the plants into line, that the strong plants (which grew in the same bed) received an additional and perhaps untrue advantage. Even then, some of the plants could not be made to bloom.

It may be well to say, once for all, that these estimates of floral novelties are not mere hurried and incidental measurements and opinions. When any flower is under test, at least one man lives with it when it is in bloom. He spends the greater part of his time with it. Every description of the varieties is read and compared with the plants, the flowers are studied from every point of view, and an opinion is obtained from every visitor who has a critical knowledge of the subject. This careful study day by day is more than the florist, busy with the demands of trade, can expect to give. The errors, therefore, are those which are to be attributed to faulty judgment and to the behavior of plants grown from poor stock. In the following chrysanthemums, for example, the judgments are not those of Mr. Miller alone. They are a compound of the opinions of himself, Mr. Hunn, myself, and of many persons who visited us.

This means that we desire to do more, if we can, than to make a mere variety test. We should like to keep pace with the range of variation, the tendencies, and the needs, in any plant which we study. We have no desire simply to recommend varieties. We have no interest in a variety as such. If, for example, we commend Lenawee amongst chrysanthemums, it is not because we have the slightest concern for that variety as an entity or trade novelty, but simply because that name has been applied to what seems to be the highest development of a particular type of white flower. We hope that the evolution will reach a higher point in the present year.

A leading difficulty with old varieties of any flower is the fact that they tend to run out by variation. The very fact that such various results are got from different grades of stock is proof that

a variety may soon be broken up into a number of strains, some of which may be good and others bad. The careful grower, therefore, will either propagate his own stock of the varieties which he likes or else exercise the greatest care to see that the stock he buys comes from plants which are true to the type.

In respect to the varieties of chrysanthemums, I am convinced that there is too great a tendency to grow novelties. Some of the old varieties are still the best of their class and should be retained, and very many of the novelties—in fact, most of them—seem to represent no distinct advance. It appears to us as if these novelties are not always thoroughly tested and understood before introduction. If we could have a few extra-choice things introduced each year and all the rest left in oblivion, the interests of all parties would be more permanently enhanced.

We need, also, to give greater attention to the hardy or border varieties of chrysanthemums. We have given such exclusive attention to the glass-house flower that the very name chrysanthemum has come to mean, to people at large, the great, noble, florists' flower of November. But there are humbler forms of the plant which may be set in the open ground and there allowed to remain year by year, the same as they did in our mothers' gardens. Some of the modern forms of these plants are pretty and interesting. Even the old-time forms are not to be despised, for if they lack size and quality of bloom, they nevertheless give a wealth of color with very little trouble. The title-page illustrates an old-time, out-door type of chrysanthemum familar to a former generation as garden artemisias. Their chief merit is hardiness; The flowers are produced in great profusion, and they extend the season of pompons a month or more after the first frost has killed the dahlias. It is the race from which the large Chinese chrysanthemums of the greenhouses are said to be derived. We still see them in the old gardens, in various shades of red and yellow, and running into whites of the form of Comet asters. The flowers on the title-page are natural size.

## II. CORNELL NOTES OF 1896. (*Wilhelm Miller.*)

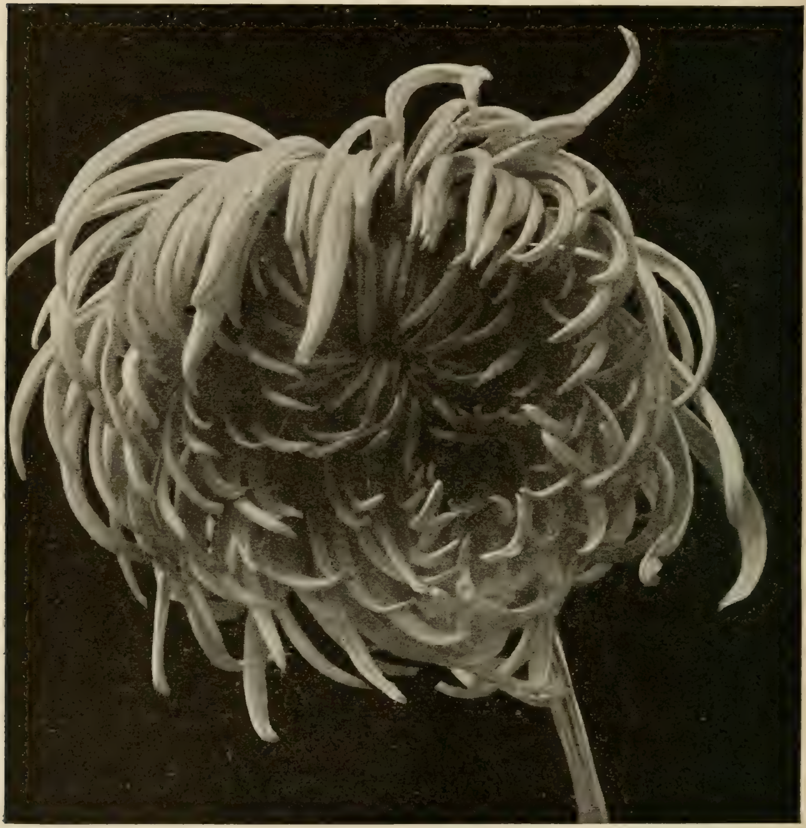
*Chrysanthemums at home*—The principles underlying the cultivation of chrysanthemums are the same as those of other plants. Specific directions are given in bulletins 91 and 112. There are two other points which it is well to know. The choice of varieties is all-important to those who delight in getting the highest results from skill and patience. The form can be chosen

80.—*Oriental Glory.* Natural size.

from the illustrations in some of these bulletins and the description will tell the color. It is well to make a list with several substitutes. The best plan of all, if you attend chrysanthemum shows in the fall, is to note down the names of desirable varieties in case the names are given, as they should be. Another good point to understand is the theory and practice of draining a flower pot. The florist who is unwilling to show a buyer how he can straddle the stem of a plant with two fingers, tap the pot gently and lay bare the whole root system and drainage of his plant, is losing an opportunity to instruct his customer and to hold his future interest. If anything is wrong with a potted plant, look at the roots. Some people are afraid to handle plants. A potted plant has no objection to being turned upside down, and whoever has seen the broken bits of crock and the reason for the hole in the bottom of the pot (not made to be closed) will never again sprinkle the leaves of a plant or the surface of the soil only, when he desires to water it. Nature soaks her plants once in a while and capillarity does the rest. Chrysanthemums are for the common people as well as for the florist. Buy strong plants early (in May or early in June) and if you have no pots, plant them in small soap boxes. Make the soil rich, keep the plants free of insects and away from strong winds, train the plant into four or five strong branches (or more or less, as you desire), and pinch out all the buds, save eight or ten. If you want the largest blooms, grow to a single stem and allow only one flower to a plant. As cold weather approaches, the plants may be moved to the window, where they should bloom to perfection.

Amateurs are frequently disappointed in the growing of the novelties. The system of prizes and certificates is of more use to the professional or exhibition grower than to the amateur who is looking for a list of varieties. No amateur can make a mistake who gets good plants of *Laciniatum*, one of the good old forms. *Lillian B. Bird* is one of the most attractive of the tubular kinds and has always had, at Cornell, the softest and purest of light pinks we know among chrysanthemums, unless it be *Good Gracious* (See Fig. 81). This figure shows a "low center" and a "weak neck" two of the ancestral bogies of florists.

The very droop of this stem seems to me to add to the beauty. Indeed, chrysanthemums in vases are sometimes so stiff-necked that they cannot see anything but the ceiling. The list of good old varieties is large, and any wide-awake florist can give reliable information concerning them.



81.—*Good Gracious*, one of the older types.

*Cultural notes of the 1896 test.*—In 1895, our novelties were grown to a single stem and allowed to produce only one flower each. This is certainly the best commercial method of obtaining exhibition blooms and large cut flowers for sale in the cities.

For all other purposes there is more satisfaction in having three to six flowers on a plant, as we did the past year.

We have never received so uneven a lot of plants as in 1896. It seems to be hopeless to get a uniform lot of plants representing all the novelties, in the year of their introduction. The last lot of American varieties came last year on the last day of August and the plants that were fit for testing together were not planted out in the bed until August 22, a month late for ideal results. This bed was composed of well rotted clay sod and manure, in the proportion of four to one. A liberal sprinkling cf bone meal was worked in, and the bed thoroughly cultivated by hand. On the 26th of September, applications of liquid cow manure were begun. Never was there a more uneven lot of plants than those shown in our photographs of the bed, and never has Mr. Hunn, in his long experience with chrysanthemums, dared to give the bedded plants so much stimulating food. The results far exceeded our expectations, and the November display was a brilliant one, although the novelties themselves were not intrinsically as meritorious with us as in 1895, which was a year of exceptional advances.

The importance of beginning early can hardly be over-estimated. We got the best results from such plants as the largest one shown in Fig. 82. This was the typical home-grown plant from March cuttings. The next largest plant was a fair sample of a lot grown from rooted cuttings received April 22. The four small plants represent fair samples of lots received from different sources in summer. All of them were represented in the trial bed and none gave anything like the satisfaction we got from home-grown plants of varieties introduced the year before. There are two great factors in producing chrysanthemums,—the quality of stock received and the subsequent management. How important the former element is may be seen by contrasting Figs. 83 and 84. Here we have the best results that we were able to produce from poor and good stock. Notice how much fewer and weaker the rays are in the one case, and how completely double is the flower of Fig. 84. Indeed the latter has the over-fed look which one often sees in the exhibition hall. Coarse, heavy rays are are not always a varietal characteristic but usually a mat-

ter of gross feeding, which really obliterates the more refined individuality.

*A great year for whites*—The year 1895 was marked by great advances among the yellows, and 1896 saw the introduction of many new types of whites. Out of more than one hundred varieties grown at Cornell, five of the six best were whites. These five, *Lenawee*, *Lady Esther Smith*, *Infatuation*, *Yanoma* and *Gretchen Buettner*, are all highly individual and attractive in form. For the third one on this list, *Mrs. W. P. Raynor* would

82.—Photograph Aug. 22. The two larger plants were potted early,—the four small ones received in July.

furnish almost an even choice. We dare not condemn it for being only a few days later, for that may not be a varietal character and no one can know, in a single season, whether it is a matter of culture or variety. Three others are strongly recommended by growers, *Autumn Bride*, *Mrs. H. H. Battles* and *Mrs. R. Crawford*, the first two for earliness, the last for lateness. These three were of familiar types and one of them we have had to condemn for other reasons. The other two we have noticed merely for their seasonable characters, of which no experiment station can judge as well as the large growers can. Three others

we have reluctantly placed on the list of promising sorts, *Miss Helen Wright*, *Dancing Maid* and *White Swan*. We shall try them again and secretly hope that they may be able to hold a place amidst increasingly severer competition. It is hard to pass over *New York* and *Gov. Matthews*, which were first-class in

83.—*Miss Magee*. The best that can be done with poor stock.

every respect but too much like *Mrs. R. W. E. Murray* (recommended in Bulletin 112) to be mentioned except as worthy substitutes. *Gov. Matthews*, it is true, is advertised as a pink, and so were *Mrs. Harry Toler*, *Sibyl Kaye*, and *Rosy Emperatrice*, but they all speedily turned white and were well worth the price as such, the two last, particularly, being an almost even choice

with *Infatuation* and *Lenawee* respectively. *Western King* had a faint primrose tinge but would pass for a white at a distance. *Robert F. Hibson* marks no advance in form, but its productiveness makes it a first-rate commercial white. So far as I know,

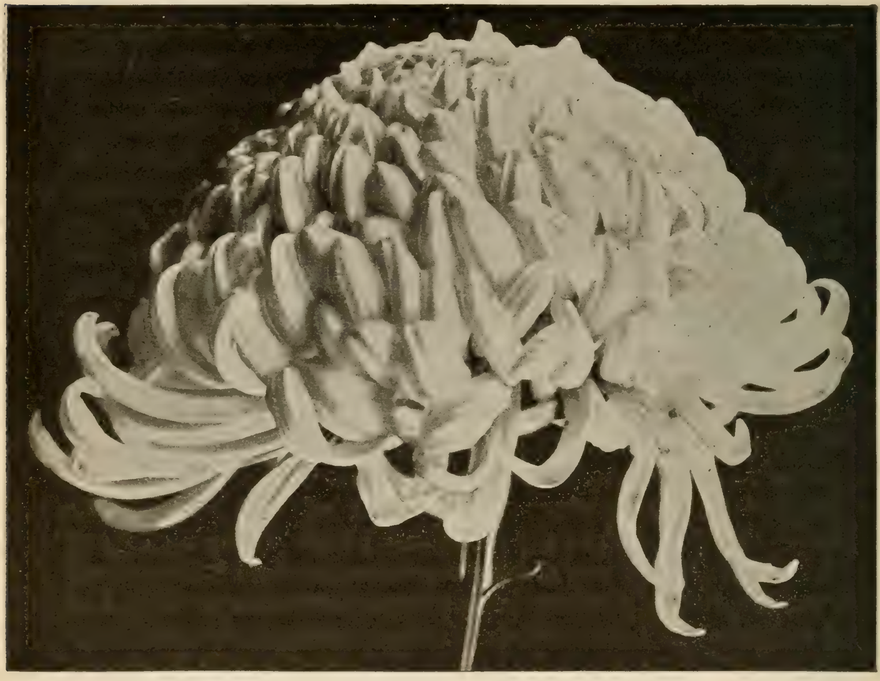
84.—*Miss Magee.* Showing what can be done with good stock. The name is nothing; the quality of the plant is everything.

the ideal hairy white variety is not yet known. *Mrs. Alpheus Hardy*, the first of the type and the one which started the chrysanthemum craze in America, is still extensively grown, but requires experience and skill to bring to perfection. The well-known *L'Enfant de Deux Mondes* is usually weak-necked.

In the yellows, the only advances in form were *Duchess of York* and *Buff Globe*, which latter looks like a buff sport of *Good Gracious* (Fig. 81). *Modesto* had nothing new in form or color but was unusually productive and has the look of a plain, every-day, successful, yellow chrysanthemum.

The pinks were a disappointment this year. Fourteen we have dropped outright. Two varieties (*Sibyl Kaye* and *Rosy Emperatrice*) were first-rate whites but were pink for only a few days. The only successful pink of the year amongst our lot, was *Mme. Felix Perrin* (or *Mrs. Perrin*, for they were as like as two peas), but we feel little confidence in the permanence of the color. We disagree as to the attractiveness of the oft-illustrated *Wm. Simpson*, as men always must differ in matters of liking, but we are agreed that our single plant had a weak stem and poor foliage. Two others, *Mrs. W. C. Egan* and *Miss L. Magee* we have indulgently placed on the promising list because we believe that we had weak stock. The real truth of the matter is that a pure and permanent pink seems not to have been attained. The various shades, from crimson to the faintest crimson-pink, are all treacherous. Even *Viviand Morel*, which is perhaps the best known of all the pinks, old and new, varies in intensity and quantity of color as much as the rest. We do not see how small growers can afford to buy new pinks unless they are sure of the quality of the stock. The number of varieties is very large, and the vigor of the individual plants, according to our experience, is of vastly greater importance ; indeed it often seems to mean all the difference between success and failure. Kind and quantity of plant-food doubtless have something to do with bringing out color, just what we hope to find out this year by experiment on a wide range of shades. Perhaps, too, there are minor and undiscovered causes of this variability, and if there are any uncontrollable factors it is high time that the truth be known. What makes the problem peculiarly puzzling is that *Good Gracious* and a few other varieties have always had at Cornell a uniform amount of delicate light pink with no trace of crimson pink origin. Nevertheless we have never seen any chrysanthemum which matches the pure pink of Schuyler Mathews's color chart.

There seem to be at least four important factors that have to do with intensity of color,—quality of stock, time of rooting cuttings, food supply, and shading. How they are related and which are the most important, it is impossible to say at present. This much is clear, that mere vigor of plants is not all. We never had better plants in any way than *Rosy Emperatrice* and *Sibyl Kaye*, but the color simply showed itself, and was gone.



85.—*Rosy Emperatrice*. Reduced from a ten-inch flower.

Of the various combinations of red and yellow, two are recommended, *Pluto* and *Helen Owen*. Perhaps their forms are not entirely new, but *Pluto* was apparently ideal in all respects within its natural limitations of form and color, and *Helen Owen* was surely the second best of all the English varieties received as regards vigor and productiveness. Six other combinations of these colors were condemned for various reasons and five placed

on the promising list. It seems hard to put *Edwin A. Kimball* on a probation list, for it was perfect of its kind with us last year, but the competition is too keen, the popularity of its type limited, and there is always the possibility of a second year's cultivation reversing one's judgment. So far as we know, it is the best American variety of the type of which *Mrs. C. H. Wheeler* was a famous early representative,—the high-built, almost conical form with heavy, incurved rays, offering frequent suggestions of dark red, while the old-gold of the reverse is the chief feature in the general effect. ("*The Golden Flower, Chrysanthemum*," Mr. Mathews's beautiful art-work has a colored picture of *Mrs. C. H. Wheeler*. That variety appears to be not double enough to suit the florists.) Four English varieties of the same sort have been gathering strength for a fair race with *Edwin A. Kimball* this year, and only one can win.

Two green-flowered plants had little to commend them. They were too exhausted to do much more than declare themselves no monstrosities like the green rose and the green dahlia, but their flowers were weak and yellowish. We shall await their return with curiosity.

Nearly all of the varieties of 1895 recommended in Bulletin 112 were grown again this year, and in general they were not disappointing. *Mrs. Henry Robinson*, the best white of 1895, was not as early in 1896, as expected. *Crimsona* was badly spotted on the face of the rays with the color of the reverse. A rush of work at a critical time caused this collection to be neglected during the disbudding season and we got plants bearing great numbers of small blooms. The mass-effect was very strong, but nearly all of the pronounced types of the year before suffered a loss of individuality. The labor of disbudding chrysanthemums is great and one must always get ahead of the plants.

*The variety test of 1896* has been conducted as formerly,

NOTE.—One of the novelties of the year was the Edible chrysanthemum. The plant was the earliest 'mum in the entire collection, but it was of poor habit and bore very few leaves and had a medium-sized yellowish flower of small merit from the florists' standpoint. This variety is said to be cultivated extensively in Japan for the flower heads, which are boiled and eaten ; but we fail to see why this particular variety is more edible than other 'mums.

L. H. B.

photographs, dried specimens, and notes on botanical and horticultural characters being taken. In color determinations, the chart of F. Schuyler Mathews proved as satisfactory as with the dahlias. It answered our purpose well, but the florists and

86.—*Lenawee.* From a white flower eleven inches in diameter.

cataloguers can hardly be expected to use the terminology of the artist. In trying to help the raiser of novelties and the purchasing florist, we shall this time try an experiment. Instead of writing technical descriptions which are apt to be dreary and

mystifying to the general reader and of interest only to the trade, we have given accounts of behavior and judgments of merit. The men who created these things have described them in their own catalogues. Moreover, no description can have the influence of a picture, and in this picture-making age there are few novelties that are not illustrated in the catalogues or trade journals.

While all admit that it is unsafe to recommend or condemn any novelty on one year's acquaintance, some judgment must be made. By placing the word "good" at the head of the following list we do not mean to guarantee the essential and permanent merit of any variety. These varieties are the ones that behaved best with us, and of the hundred or more sorts tested, these twenty are, in our judgment, the ones most likely to achieve anything resembling permanent success. But the problems of variety-study must forever contain uncontrollable factors. The analysis can never be complete, and therefore the prophecy can never be as certain as in some other departments of science.

## GOOD VARIETIES.

Twenty-four varieties are named somewhat in the order of merit under their respective colors. The names in parentheses indicate the source of stock plants and usually the introducer.

### *Whites.*

*Lenawee* (Smith).—By far the largest and most attractive flower in our collection of 1896. The form is strikingly individual. Early, prolific and one of the longest keepers. The only possible objection to it is that it may be too flat and sprawling for use in bunches of cut flowers. Fig. 86.

*Smith, Lady Esther* (Owen).—Easily the largest and best of the varieties received from England for trial. Rays four inches long and often an inch or more wide, very flat, and of good substance. Apparently quite ideal.

*Infatuation* (May).—Smaller than the last but of good size. Early, and lasts three weeks on the plant. Form distinct and attractive. *Mrs. W. P. Raynor* was a few days later with us, but otherwise almost an even choice with *Infatuation.*

*Yanoma* (Smith).—By far the best late white we have ever grown. Exceptionally prolific, and has all the traits of thoroughbred commercial sorts.

*Buettner, Gretchen* (Hill).—A high-built flower of strong enough character to be worthy of a permanent place in the much overcrowded midseason section.

*Hibson, Robert F.* (P. & M).—Advertised as an early, reflexed Japanese. was midseason with us, prolific, and a good commercial variety.

*Raynor, Mrs. W. P.* (Spaulding).—A few days later than *Infatuation* but otherwise an almost even choice.

*Autumn Bride* (Smith).—Mentioned only because of its being the earliest white with us this season. Flowers do not last long.

*Crawford, Mrs. R.* (Spaulding).—Noticed because it is a late white. Of its lateness and commercial qualities no experiment station can judge as well as growers. *Yanoma* was more prolific and the form more attractive.

*Pinks.*

*Perrin, Mme. Felix* (Smith).—Best crimson pink in the bed. The form is regular, incurved, and somewhat stiff. Color faded slightly. Recommended only as being the best pink of the year and not for any permanent advance.

*Perrin, Mrs.* (Hill).—Color and form were not distinguishable from the above. A few days later was the only difference with us.

*Simpson, Wm.* (Blanc). The form of this crimson pink variety is more unusual and less conventional than of the preceding. Our single plant had a large, early, long-keeping flower which faded little, but the foliage was so scattered and the neck so weak as to make it impossible for us to recommend it from our experience for extensive commercial use.

*Rosy Emperatriee* (Yoshiike).—Pink for only a few days, rapidly fading to white. Almost as large and long-keeping as *Lenawee* and of similar form. Fig. 85.

*Kaye, Sibyl* (Spaulding).—Faded from pink to white as rapidly as the last, and kept for a long period. The form is somewhat similar to that of *Infatuation*.

*Yellows.*

*York, Duchess of* (Hill).—Form reflexed, loose, graceful and flowing. Color a soft and rather light yellow, beside which the next is bold and metallic. It is on three of our four lists of recommended varieties, for it is one of the best yellows we have ever seen.

*Modesto* (Smith)—Form common but popular. Color bold and strong. It has all the marks of a successful commercial variety.

*Other Colors.*

*Pluto* (May).—Red, reverse yellow. The best of its color and type yet seen at Cornell. While essentially a commercial sort, it is just the thing for amateurs because of its interesting stages of development.

*Buff Globe* (Yoshiike).—Noted as having the peculiar form and drooping habit of *Good Gracious* which is very attractive to many people. The color is pretty and restful but cannot compete for attention in a large crowd with the more vivid ones.

*Owen, Helen* (Owen).—A deep, quickly incurving Japanese flower, with a low center like that of *Good Gracious*, the youngest rays tightly whorled and showing the sulfur reverse. Face of rays chiefly brownish flesh and yellow. There is plenty of room for this and *Pluto*.

*Violescent* (Smith).—A large, deep, compact flower, the pinkish tinge being delicate and rather short-lived with us. An ideal commercial and exhibition sort, if one could be sure of the color. Even as a white variety, however, it would be a distinct success.

*Oriental Glory* (Yoshiike).—High built, compact, cylindrical, whorled, white, the whorled inner rays suffused with delicate crimson pink which fades as flower becomes older. The cylindrical form relaxes about the same time to the spherical. We had only one plant and one flower and cannot judge of its commercial qualities. Fig. 80.

*Western Pride* (Yoshiike).—Cardinal, reverse greenish yellow. Recommend to amateurs who like fantastic and Japanesque creations. The younger stages are the most eccentric and interesting.

*Hairy.*

*Midnight* (Spaulding).—Noted because it is an odd color in this class. The shade of crimson is rather dull and not as attractive as the familiar *Louis Boehmer*. *Mrs. H. N. Higinbotham* has been grown here to a much greater size.

*Freeman, Mrs. C. B.* (Spaulding).—This is the only yellow variety we have seen of this class. The color fades as much as the very popular *Philadelphia*.

From the preceding twenty-four varieties we have made selections for special purposes:

General collection of ten for commercial purposes: *Lenawee*, *Lady Esther Smith*, *Infatuation*, *Mme. Perrin*, *Pluto*, *Modesto*, *Duchess of York*, *Yanoma*, *Violescent*, *Gretchen Buettner*.

Six varieties for exhibition: *Lenawee*, *Lady Esther Smith*, *Mme. Perrin*, *Pluto*, *Modesto*. To complete the set Mr. Hunn and Mr. Hasselbring (a practical florist) would choose *Violescent*; Mr. Miller would choose *Oriental Glory*.

Six varieties for pot plants: *Lenawee*, *Mme. Perrin*, *Pluto*, *Modesto*, *Duchess of York*, *Yanoma*.

Amateur's list of six: *Oriental Glory*, *Duchess of York*, *Mrs. C. B. Freeman*, *Buff Globe*, *Gretchen Buettner*. To complete the set Mr. Hunn and Mr. Hasselbring would choose *Helen Owen*; Mr. Miller would choose *Western Pride*.

## PROMISING VARIETIES.

The following list contains varieties of all degrees of merit, and especially those which by reason of lateness of arrival (e. g. the English), or poor quality of stock, did not have fair play this season. The figures at the left are the numbers of the varieties on our own books.

8. *Alps.*
1. *Ashmead, F.*
4. *Avellan, Amiral.*
10. *Bonnie Dundee.*
12. *Buettner, Emil.*
28. *Dancing Maid.*
29. *Devis, W. S.*
30. *Egan, Mrs. W. C.*
33. *Emerald Gem.*
36. *Godfrey, Mrs. J. W.*

38. *Green Emerald.*
45. *Invincible.*
48. *Ito, Admiral.*
54. *Kahma.*
50. *Kimball, Edwin A.*
61. *Magee, Miss L.*
60. *McHattie, J. W.*
72. *Owen, Walter.*
82. *Ridgeway, Lady.*
81. *Roberts, Gen.*
94. *Taiwan.*
87. *Triomphe de St. Laurent.*
99. *Western King.*
98. *Wright, Miss Helen.*

### UNPOPULAR VARIETIES (*the Chinese type.*)

The varieties 20 and 88 here named were the best of the novelties in this now unpopular class. These varieties are good of their type, but the Chinese or ball-form class is in such little favor that it seems almost necessary to put these varieties in the unpromising list. All the rest of our Chinese sorts of the year were much below the average of what we have formerly seen.

13. *Bock, Betty.*
21. *Columbine.*
20. *Curtis, Chas. H.*
44. *Haigh, George.*
42. *Hatfield, Mrs. T. D.*
51. *Kingston, Mrs. R. C.*
62. *Mongolian Prince.*
88. *Signal Light.*

### LESS PROMISING VARIETIES.

The following list of less promising varieties contains those novelties in which we seem to detect essentials that are likely to disqualify them permanently; the judgments are formed solely upon the behavior of the plants at Cornell in 1896. How to treat the great number of sorts that are no improvement on old and established kinds but apparently just as good, is a perennial puzzle. (I am not speaking of those that are identical, but of those that are so similar as to be horticulturally synonymous.) Our rule is to offer them as equivalents or substitutes whenever their merits are urgent, and discard the rest. Fine flowers do not make fine varieties. We know how the old plants respond to cultural conditions, but what of the new?

Varieties and fashions are proverbially ephemeral and our judgments can hardly be as ruthless as those of Time himself—the Prince of novelty testers. Probably not ten of these hundred new things will be alive in another decade.

The amateur, who loves everything that grows, feels no failures. To the florist, disappointment means dollars. What does the lover of plants care for shipping qualities or the lastingness of cut flowers? The enthusiast's standards do not know the oxidizing touch of trade.

To the introducer and to the florist, we merely report that the varieties named below seemed failures to us for reasons that we will gladly communicate privately, just as we are glad to furnish an account of the behavior of any collection of numbered seedlings, which may be sent us. No variety has been dropped for any one reason, and particularly not for misbehavior during one season, for such failure is sometimes a matter of variety and sometimes a matter of individual plants. We give in brief compass some hints as to the most obvious defects in the varieties named below. To avoid multiplication of words, numbers are used instead of names:

Lacking size 16, 19, 91; poor habit 32, 39, 58, 68; lacking productiveness 18; too much center 6, 39; raggedness 7; coarse and heavy 11; seasonal (not early or late as advertised) 16, 91, 35, 65; crimson pink (color unstable, or badly laid on) 3, 5, 6, 7, 11, 19, 24, 35, 37, 57, 65, 75, 85; foreign to Amerall the Chinese; dark colors unpopular for cut flowers 43, 55, 58; red-andican taste 49, and yellows more popular in England than here 22, 67, 70, 83; no improvement over old sorts known to us 22, 39, 41, 43, 52, 59, 65, 68, 70, 73, 77, 78, 83, 91, 100.

7. *Alonzo.*
3. *Amaranth.*
5. *d'Angleterre, Reine.*
6. *Antoinette.*
16. *Battles, Mrs. H. H.*
11. *Biddencope, J.*
18. *Budd, Gov.*
22. *Clarence.*
19. *Consuelo.*
24. *Dalskov, Miss Agnes.*
32. *Edible.*
35. *Glory of the Pacific.*
39. *Golden Harvest.*
37. *Great Port.*
43. *Headlight.*
41. *Hurrell, Henry.*
49. *Jones, M. H. J.*
52. *Keim, J. R.*
55. *Lear, Miss M.*
59. *Liberty.*
58. *Loomis, Adelaide.*
57. *Louise.*
67. *Mars.*

65. *Matthews, Gov.*
68. *Miller, Paul L.*
69. *Nanshon.*
70. *New York.*
73. *Oyama, Marshall.*
78. *Peabody, Mrs. J.*
75. *Pratt, Cecil.*
85. *Rena Dula.*
83. *Rinaldo.*
90. *Snow Field.*
77. *Souvenir de Petite Amie.*
91. *Terrell, Constance.*
93. *Tippecanoe.*
97. *Violet King.*
100. *Whitcombe, Jessie.*
101. *White Swan.*

## NOT TRUE TO NAME.

9. *Bellem.*—Not true to description. Advertised pink. Was primrose-yellow
14. *Buettner, Mrs. Emil.*—Not true.
31. *Ellis, Ruth.*—Not true. Advertised as blush white. Was a faint yellow fading much more than *Philadelphia.*
92. *Toler, Mrs. Harry.*—Advertised as flesh pink, slightly hairy, full and double. With us, this was a good commercial midseason white but *Robert F. Hibson* was more completely double.
103. *Yellow Plume.*—Was pink with us.

## SUMMARY.

A few plants can be grown in the home window and made to produce flowers equal to any pictured in this bulletin. Page 305.

Take note of varieties at your local flower shows and insist on the educational side of the exhibit.

Amateurs will take most comfort in growing plants having three to six large characteristic flowers. Page 307.

The quality of stock plants is of the highest practical importance. Page 307.

The great advances in form among the introductions of 1896 were made in the whites. Page 308.

*Modesto*, the most productive yellow of the year, is typical of commercial standards. Page 311.

No true pure pink appears to have been obtained in chrysanthemums.

The intensity of color among the so-called pinks depends upon little-understood cultural conditions. Page 313.

Lists of varieties recommended on the basis of one year's behavior on Page 317.

List of varieties that failed to give satisfaction at Ithaca in 1896 on Page 320.

L. H. BAILEY.
WILHELM MILLER.

**Bulletin 137.** **May, 1897.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

# Agricultural Extension Work:

## SKETCH

of its

## Origin and Progress.

PUBLISHED BY THE UNIVERSITY

ITHACA, N. Y.

1897

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| | | |
|---|---|---|
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Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

## BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk about Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums.
132. Notes Upon Celery.
133. The Army-worm in New York.
134. Strawberries under Glass.
135. Forage Crops.
136. Chrysanthemums.
137. Agricultural Extension Work, sketch of its Origin and Progress.

# AGRICULTURAL EXTENSION WORK:

# SKETCH OF ITS ORIGIN AND PROGRESS.

The law under which the extension teaching of agriculture is now being prosecuted in New York State by the College of Agriculture of Cornell University, at first was an Experiment Station measure. The bill originated entirely with the people, when, in 1893, certain Chautauqua County persons asked the Station to undertake experiment work in their vineyards. We replied that while we should like to take up the investigations, our funds were insufficient to meet the expense without endangering work in which we were already engaged ; and this lack of funds would be keenly felt if other sections of the state should also, following the Chautauqua example, ask for help. We suggested to them, therefore, that if their local horticultural society could raise sufficient funds to meet the expense of fertilizers, traveling and incidentals, we would try to detail a man to look after the work. The matter dropped there ; but the next winter we heard of a movement among the Chautauqua people to obtain a small state appropriation to pay for experiment work in their vineyards. The project was placed in the hands of S. F. Nixon, Assemblyman from Chautauqua County, who, early in 1894, obtained a grant of $16,000, one-half of which was to be expended by the Cornell Experiment Station in work in horticulture in the Fifth Judicial Department of the State, an area comprising sixteen counties of western New York. This is the only instance, so far as we know, of a movement for experiment station work which has been initiated and pushed to a final passage wholly by a farming community. The laws upon which our land-grant colleges and the agricultural experiment stations are founded were conceived and completed almost wholly by a comparatively small body of educators and experimenters, aided by persons in the various professions.

The clause in the law of 1894 which appropriated money to

the Cornell University Experiment Station, is as follows: "The sum of eight thousand dollars, or so much thereof as may be necessary, is hereby appropriated, to be paid to the agricultural experiment station at Cornell University, for the purpose of horticultural experiments, investigations, instruction and information in the fifth judicial department, pursuant to section eighty-seven of the agricultural law." The law also provides that "such experiment station may, with the consent and approval of the commissioner of agriculture, appoint horticultural experts to assist such experiment station, in the fifth judicial department, in conducting investigations and experiments in horticulture; in discovering and remedying the disease of plants, vines and fruit-trees; in ascertaining the best means of fertilizing vineyards, fruit and garden plantations, and of making orchards, vineyards and gardens prolific; in disseminating horticultural knowledge by means of lectures or otherwise, and in preparing and printing, for free distribution, the results of such investigations and experiments, and such other information as may be deemed desirable and profitable in promoting the horticultural interests of the state. * * * * All of such work by such experiment station and by such experts shall be under the general supervision and direction of the commissioner of agriculture." This bill became a law, by the Governor's signature, May 12, 1894. In the legislature of 1895, Mr. Nixon introduced a bill to continue the work, but increasing the amount given to Cornell University Experiment Station to $16,000. This second bill became a law on the 4th of April, 1895.

Upon taking up the work provided for by the bill, in the early summer of 1894, the Cornell University Experiment Station placed the enterprise in the hands of a chief "horticultural expert," in the language of the law, and Professor L. H. Bailey was chosen to that office, with the expectation that most or all of the work should be completed during the summer interrim. In entering upon his duties, this officer laid out three general lines of work, as specified in the law,—"conducting investigations and experiments," "disseminating horticultural knowledge by means of lectures or otherwise," and "preparing and printing" the results of the work. In other words, the work was to be divided between research, teaching, and publication.

The enterprise was new and untried ; the territory to be covered was large, the interests varied, and the demands numerous ; and the promoters of the bill had large expectations of the results. The responsibility of inaugurating the enterprise was keenly felt, or a mistake in the beginning might be expected to exert a serious and baneful influence upon future legislation designed to improve the conditions of rural life. The officer in charge was extremely fortunate, however, in having the hearty support of his colleagues, the free coöperation of the commissioner of agriculture, and, above all, the kindly and intelligent interest of scores of horticulturists in his territory. It was conceived that, in the beginning, a comparatively small and well digested enterprise prosecuted by a few carefully chosen men would be productive of better results than any bold attempt, with a large force, to carry the work into every part of the fifth judicial department. Inasmuch as the original grant was obtained through the exertions of the grape-growers of Chautauqua County, it was designed to undertake careful studies of the vineyard interests at the outset. The immediate charge of this work was placed in the hands of the late E. G. Lodeman, assistant in horticulture, who, to fit himself more specifically for certain problems which were presenting themselves, went to Europe (at his own expense) and visited the vineyards of the Rhine, of Italy and Southern France. The entomological inquiries were placed in the hands of M. V. Slingerland, assistant entomologist of the Experiment Station. Certain lines of investigation made at Ithaca were placed in immediate charge of Michael Barker, who was secured from the Botanic Gardens of Harvard University. We also associated with us for a time in certain field work, Harold G. Powell, a senior in agriculture in Cornell University, and one who had had much experience in pomological matters.

In 1895 the work was placed under the supervision of Professor I. P. Roberts, the director of the station (who was absent the previous year) and Professor Bailey, but immediate charge of it was given, as the year before, to the latter officer. Some additional help was secured because of the larger work which was demanded by the larger appropriation ; but in general the enterprise went forward upon the same lines as in 1894.

A third appropriation was made by the legislature of 1896 of $16,000; but since the new state constitution had abolished the Fifth Judicial Department, the fund was applied to the Fourth Judicial Department comprising twenty-two counties bounded eastward by Jefferson, Lewis, Herkimer, Oneida, Onondaga, Cayuga, Tompkins, Seneca, Yates and Steuben.

The legislature of 1897 made a fourth appropriation, but now it applies to the entire state and to agriculture in general. Moreover, it is given to the College of Agriculture (not to the Experiment Station) for "the promotion of agricultural knowledge in the State." For this purpose $25,000 was appropriated. The attachment of this fund to the general College of Agriculture signalizes the outgrowth of the work from mere experiment (as chiefly contemplated at first) into the general promulgation of agricultural knowledge. With this new bill, the prosecution of the work passed from the hands of Professor Bailey into those of Professor Roberts, the Director of the College of Agriculture.

From the first, the work has been thrown into three general lines,—direct research in the orchards, vineyards and gardens of western New York; teaching by means of itinerant schools and lectures; and the publication of horticultural knowledge in bulletin form. A somewhat full account of the enterprise up to nearly the time when it passed wholly from Professor Bailey's hands may be found in Bulletins 110 and 122. From the funds of the first three years—when the work was restricted to horticulture—49 bulletins have been published, and investigations for several others have been completed. These bulletins have been of five general types: 1. Those which attempt to improve the cultivation of the staple crops; 2. Those which endeavor to expound well known principles and facts; 3. Those which aim to awaken an interest in flowers and nature and the amenities of rural life; 4. Those which suggest new avenues of profit; 5. Those which attempt to monograph certain difficulties (as given insects and fungi) with which the horticulturist has to contend. In all of them, it has been the desire to make the matter attractive and readable, so that the entire bulletin would be prized and kept by the recipient.

The animus of the entire enterprise has been an attempt to

inquire into the agricultural status, to discover the causes of the rural depression, and to suggest means for improving the farmer's position. This attempt has been specifically directed to a single great branch of rural industry, horticulture, in pursuance of the provisions of the law; but what is true of the horticultural communities is essentially true of other agricultural regions, and, morever, these two types of agricultural industry cannot be separated by arbitrary lines. The work, therefore, has practically resulted in a broad study of rural economics. We conceive that it is impossible to really extend the Experiment Station and University impulse to the people in such manner that it shall come to them as a living and quickening force, without first studying the fundamental difficulties of the farmers' social and political environment.

In this extension work, therefore, we have sought not so much for new facts as for some way of driving home the old facts. We have tried to set forces at work which would silently extend themselves when we had left them. Fortunately, we have been greatly aided by the hard times and the multitudes of bugs and special difficulties. These things have driven people to thinking and to asking for information. The agricultural communities are thoroughly aroused, and now is the time to teach. When one is thoroughly prosperous in his business, there is little chance—as, in fact, there is generally little need—of teaching him other methods.

The efforts to reach the people, in the progress of our work, may be classified under five general heads. These efforts have all been experiments in methods of extension teaching as applied to horticulture. We have tried to ascertain the value of:

(1.) The itinerant or local experiment as a means of teaching.
(2.) The readable expository bulletin.
(3.) The itinerant horticultural school.
(4.) Elementary instruction in the rural schools.
(5.) Instruction by means of correspondence and reading courses.

In the local experimental work, something over one hundred different experiments have been planned and prosecuted in differ-

ent parts of western New York. These comprise experiments in tilling the land, in pruning trees, in fertilizing the soil, spraying, combating insects and fungi, and the like. The fundamental purpose in these experiments is to teach by means of object lessons and not to collect scientific facts, although the latter often come as a very valuable incidental result.

The bulletins which have been issued under the auspices of the work are public and therefore need no explanation at the present time.

The horticultural schools have been about forty in number. These are meetings which last two or more days, at which time certain instructors take up definite lines of instruction, giving by far the greater part of their attention to underlying principles and not to mere facts or methods. A somewhat full report of these horticultural schools, with the topics and instructors assigned to each, is published in Bulletin 122.

The fundamental difficulty with our agricultural condition is that there is no attempt to instruct the children in matters which will awaken an interest in country life. We have therefore conceived that the place in which to begin to correct the agricultural status is with the children and the rural schools. For the purpose of determining just how much could be expected from this source, many rural and village schools were visited during the past year, the instructors talking to the children about any object which presented itself at the time. The result was that all the instructors were impressed with the readiness with which the children imbibed the information, their keen desire for it and appreciation of it, and the almost universal interest which teachers took in this kind of work. We are now convinced that the greatest good which can be rendered to the agricultural communities is to awaken an interest in nature-study on the part of teachers and children. In order to facilitate teaching in this direction, we have issued five leaflets to show teachers how nature-study may be presented to the pupils, and these have been received with the greatest enthusiasm by educators and others amongst our constituency. The hint for this work in the public schools was derived from the work which was done by George T. Powell, in Westchester County,

under the auspices of the New York Committee for the Promotion of Agriculture. This resulted in a virtual union of the forces in the two parts of the State, and when the people asked the Legislature again during the last winter for an appropriation, the Committee for the Promotion of Agriculture lent its influence in behalf of the bill.

The outgrowth of this work with the schools is that we now consider that the best way in which to reach the pupils and the teachers is by short and sharp observations upon plants, insects and other natural objects, and not by means of definite lectures of stated lengths. This work has already been presented to the teachers at some of their institutes, where it has also met with favor and it has received the commendation of the Superintendent of Public Instruction and other persons in authority. *It will, of course, be futile to attempt to instruct the children of the State in nature-study by means of instructors from Cornell University. We therefore conceive that the real work to be done is to instruct the teachers in the methods of imparting this instruction.* It was with this thought that we began a series of teachers' leaflets and we purpose to present the work at the teachers' institutes and eventually, perhaps, in the Normal Schools and training classes of the State. So far as the present outlook is concerned, it is perhaps not too much to say that we believe that this movement, directed towards the young people of the rural communities, is the most important one which has developed in agriculture since the consumation of the experiment station idea.

Instruction by means of correspondence has been an outgrowth of the last year and has not yet been carried to sufficient maturity to enable us to judge of its full merit and promise. However, there were about 1,600 readers upon our lists at the close of the first three months, and there is no doubt but that a vigorous agitation of the question during another winter will at least quadruple our present list. It is the plan in this reading course to set the farmers to reading upon certain definite subjects which are assigned to them, and then to make them think upon those subjects by periodical questioning. At the present time the texts which have been used are our Bulletin 119 upon the Texture of the Soil, and Bulletin 120 upon the

Moisture of the Soil. These are two fundamental subjects upon which every farmer needs more light. After having read one of these bulletins, a printed circular is sent to each reader asking certain definite questions, which it is desired that he shall figure out, think about and answer for himself. In this way the readers are kept in constant touch with the College of Agriculture, and they are made to think, whether they desire to do so or not.

Aside from the many horticultural investigations which are still continuing from Professor Bailey's work, there are now more than 200 experiments with fertilizers on various kinds of crops in progress throughout the State among the farming community. Five hundred experiments in beet culture, with and without fertilizers, are also being conducted to learn, if possible, the localities in the state best adapted to sugar beet culture and to induce the farmers to investigate this new industry. Instruction is given as to soil, methods of tillage and fertilization. At the same time, numerous experiments are being conducted at the university along lines similar to those mentioned. The College of Agriculture has enrolled under the head of University Extension work fifteen thousand pupils and ten thousand teachers of the public schools, and one thousand six hundred young farmers. The pupils and farmers receive guidance by means of printed circulars and the farmers report progress and difficulties upon special blanks which are furnished. Six instructors are employed throughout the state in conducting University Extension work, and special teachers are employed from time to time as occasion requires. These instructors meet the teachers of the public schools in the presence of their pupils and at teachers' associations and institutes for the purpose of illustrating methods for teaching Nature Studies directly or indirectly related to Agriculture. The leaflets furnished serve as text for the subjects taught.

The result of this pushing of the education motive into the rural communities has been a most decided waking up of the rural communities which, even if the work were to stop at the present time, would continue to exert an influence for a generation and more.

All this work has been experimental,—an attempt to discover

the best method of teaching the people in agriculture. We believe that the most efficient means of elevating the ideals and practice of the rural communities are as follows, in approximately the order of fundamental importance: (1) The establishment of nature-study or object-lesson study, combined with field-walks and in incidental instruction in the principles of farm-practice, in the rural schools; (2) the establishment of correspcndence-instruction in connection with reading-courses, binding together the University, the rural schools, and all rural literary or social societies; (3) itinerant or local experiment and investigation, made chiefly as object-lessons to farmers and not for the purpose, primarily, of discovering scientific facts; (4) the publication of reading bulletins which shall inspire a quickened appreciation of rural life, and which may be used as texts in rural societies and in the reading courses, and which shall prepare the way for the reading of the more extended literature in books; (5) the sending out of special agents as lecturers or teachers, or as investigators of special local difficulties, or as itinerant instructors in the normal schools and before the training classes of the teachers' institutes; (6) the itinerant agricultural school, somewhat after the plan of our horticultural schools, which shall be equipped with the very best teachers and which shall be given as rewards to the most intelligent and energetic communities.

In conclusion, it must be said that the farmers, as a whole, are willing and anxious for education. They are difficult to reach because they have not been well taught, not because they are unwilling to learn. It is astonishing, as one thinks of it, how scant and poor has been the teaching which has even a remote relation to the tilling of the soil; and many of our rural books seem not to have been born of any real sympathy with the farmer or any proper appreciation of his environments. Just as soon as our educational methods are adapted to the farmer's needs, and are born of a love of farm life and are inspired with patriotism, will the rural districts begin to rise in irresistible power.

## CIRCULAR CONCERNING

# Co-Operative Tillage Experiments.

## No. 5.

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**Cornell University,**
**College of Agriculture.**

*Ithaca, N. Y., April* 15, 1897.

It is desired by the Cornell University College of Agriculture to co-operate with farmers throughout the State in tillage experiments with potatoes and sugar beets. Such marked results have been obtained by the Experiment Station at Cornell University in the tillage of potatoes that it is considered worth while to see if equally marked results cannot be secured by the farmers generally throughout the State. The awakening interest in the home manufacture of sugar and the organization in this State of one or more companies for its manufacture from beets, demand that attention be given to the subject of the culture of sugar beets, and the fertilizers, soil and varieties best suited to their production in different sections of the State.

To assist in carrying out this work we invite the co-operation of all farmers interested, and for those who desire to enter upon this work the following details are given:

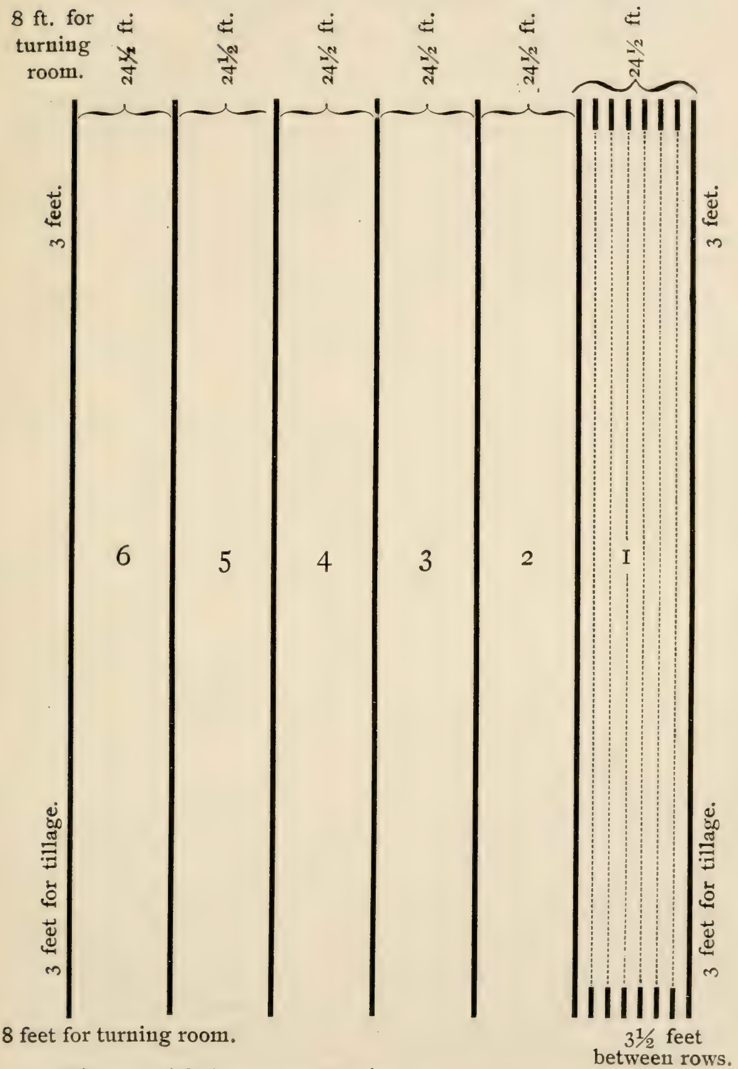
### Potato Tillage Experiments.

---

Select, if possible, a loamy soil avoiding light sands or heavy clay. If a clover sod can be plowed under it will serve the purpose well, but heavy, tenacious sods should be avoided. Select a place on which the soil is uniform in quality and all portions of which have been treated alike as regards cropping and ma-

nuring. Plow immediately, or as early as the condition will permit, and measure off the plats which are to be devoted to the experiment. It is desired that this be an experiment to determine the effect of tillage upon potatoes, and the following suggestions as to size and number of plats are given to aid the farmer in carrying out the purpose of this work. (See diagram.) Measure off a piece of land 207½ feet long and 147 feet wide. (A space of at least three feet should be allowed outside of the outer rows, indicated by the outside solid black lines, so that cultivation may be given to both sides of the potato rows. This will give the total width over all of an additional 6 feet or 153 feet.) Divide this up into six plats, each 24½ feet wide and 207½ feet long. This will provide for six rows of potatoes 3½ feet apart to each plat, and will leave a space of 3½ feet between the outside experiment rows and the edge of the plats. A space of seven feet will be left between the adjacent rows of the plats, and in this space there should be a row of potatoes planted which is to be dug before the other six rows on the plat are harvested. This extra row is indicated by the solid black lines in the diagram, and the rows of potatoes which are to enter into the experiment are indicated by the dotted lines. Planted in this way there will be one-tenth of an acre of potatoes to each plat. If it is desired to have the plats only half the size of the ones shown in the diagram, then instead of making them 207½ feet long, make them only half that length or 103 feet 9 inches long and the width the same, 24½ feet, and plant the rows the same distance apart as indicated above, 3½ feet. This will give plats of one-twentieth of an acre each. If the circumstances are such that it seems desirable to have the rows of greater length and not have the plats definitely marked off, as in the diagram, it may be done by so measuring the rows that a total of 1,245 feet in each plat shall be subject to the special tillage desired. This will give a potato area of one-tenth of an acre. If the smaller area of one-twentieth of an acre is preferred then have a total length of rows in each plat of 622½ feet. Where the plan of the diagram can be followed it is recommended so that there may be as great a uniformity of methods and results as possible. Eight additional feet should be allowed

## DIAGRAM FOR POTATO PLATS.




Plats 207½ ft. long; 24½ ft. wide.
Six rows of potatoes to the plat.

Plat 1—3 cultures.
" 2—6 cultures.

Plat 3—9 cultures.
" 4—3 cultures.

Plat 5—6 cultures.
" 6—9 cultures.

at each end of the plats for turning room, making the total length of the potato rows 223½ feet, so that during tillage that portion which is to enter into the experiment will not be injured by the tramping of horses in turning. At time of digging, eight feet at each end and the extra rows planted between plats (indicated in diagram by the solid black lines) should be dug and removed before the experiment plats are harvested.

After plowing the land this spring harrow thoroughly, breaking all clods and pulverizing the soil. Open the rows with a shovel, plow or with a double moldboard plow. Cut the potatoes so that there shall be one or two strong eyes to the piece, each piece being of good size, and drop one piece to a place and 14 inches apart in the row. Cover with a hoe to the depth of about four inches. The seed should be uniform and of the same variety. If any traces of scab are present, the potatoes should be soaked before cutting for one hour in solution of two ounces of corrosive sublimate to thirteen gallons of water. This corrosive sublimate is poison and should be handled with extreme care. Prof. J. C. Arthur, of Purdue University Experiment Station, Indiana, recommends for potato scab eight fluid ounces of Commercial Formalin (which can be purchased at the drug store) to fifteen gallons of water. Immerse the potatoes for two hours. This is perfectly safe and said to be thoroughly efficient. Before the potatoes are up, about one week after planting, thoroughly harrow all plats with a spike tooth harrow. If a heavy rain should come after this harrowing and before potatoes are up, use the harrow again on all plats, breaking up the surface soil crust. When potatoes are up so that the rows can be followed, cultivate all plats with a fine tooth implement. A spring-tooth cultivator does the work well. After this first tillage plat 1 is to have but two more cultures, plat 2 five more and plat 3 eight more. Repeat with plats 4, 5 and 6. All this is to be level culture and no hilling up. Plats will then receive tillage as follows:

| | | | |
|---|---|---|---|
| Plat 1—3 | cultivations. | Plat 4—3 | cultivations. |
| " 2—6 | " | " 5—6 | " |
| " 3—9 | " | " 6—9 | " |

The foliage on all plats must be kept intact by spraying if necessary. To prevent the attacks of the leaf flea-beetle and the blight use Bordeaux mixture, and for the common potato beetle, Paris-green. (See Cornell Bulletin 130.)

If it is desired to conduct fertilizer experiments in connection with this tillage experiment, the additional plats required may be laid off the same size and the fertilizer applied according to directions given by Dr. Caldwell. (See Cornell Bulletin 129.) It is hoped that, in addititon to the potato tillage experiment outlined above, every farmer will arrange for one or more additional plats on which to carry out his own idea of potato raising. Have one plat which shall have the potatoes hilled up in the ordinary way of hilling potatoes.

RECORD OF POTATO EXPERIMENT, 1897.—TO BE RETURNED AT THE END OF THE SEASON TO CHIEF CLERK, COLLEGE OF AGRICULTURE, ITHACA, N. Y.

Name of Experimenter..................

Post Office..........................

County........................

Kind of soil.........................................

Previous treatment of land...........................

Date of plowing...................... ...............

Manner of fitting land ..............................

Size of plats ............ ..........................

Name of variety planted..............................

Date of planting.....................................

Dates of harrowing...................................

Plat 1:

Date of first tillage ..............................

Date of second tillage ............................

Date of third tillage ..............................

Date of digging ....................................

Weight of marketable potatoes ......................

Weight of small potatoes ...........................

Remarks:

Dates of spraying ..................................

Rainfall ...........................................

Kind of implement used in tilling, etc. ............

Plat 2:

Date of first tillage ..............................

Date of second tillage ............................

Date of third tillage ..............................

Date of fourth tillage .............................

Date of fifth tillage ..............................

Date of sixth tillage ..............................

Date of digging ....................................

Weight of marketable potatoes ......................

Weight of small potatoes ...........................

Remarks:

Plat 3:

Date of first tillage ....................................

Date of second tillage ....................................

Date of third tillage ....................................

Date of fourth tillage ....................................

Date of fifth tillage ....................................

Date of sixth tillage ....................................

Date of seventh tillage ....................................

Date of eighth tillage ....................................

Date of ninth tillage ....................................

Date of digging ....................................

Weight of marketable potatoes ....................................

Weight of small potatoes ....................................

Remarks:

Plat 4:

Date of first tillage ....................................

Date of second tillage ....................................

Date of third tillage ....................................

Date of digging ....................................

Weight of marketable potatoes ....................................

Weight of small potatoes ....................................

Remarks:

Plat 5:

Date of first tillage..................................
Date of second tillage..................................
Date of third tillage..................................
Date of fourth tillage..................................
Date of fifth tillage..................................
Date of sixth tillage..................................
Date of digging..................................
Weight of marketable potatoes..................................
Weight of small potatoes..................................

Remarks:

Plat 6:

Date of first tillage..................................
Date of second tillage..................................
Date of third tillage..................................
Date of fourth tillage..................................
Date of fifth tillage..................................
Date of sixth tillage..................................
Date of seventh tillage..................................
Date of eighth tillage..................................
Date of ninth tillage..................................
Date of digging..................................
Weight of marketable potatoes..................................
Weight of small potatoes..................................

Remarks:

EXTRA PLATS FOR SPECIAL EXPERIMENT ON HILLING.

State fully the treatment given and the weight of marketable and small potatoes harvested.

---

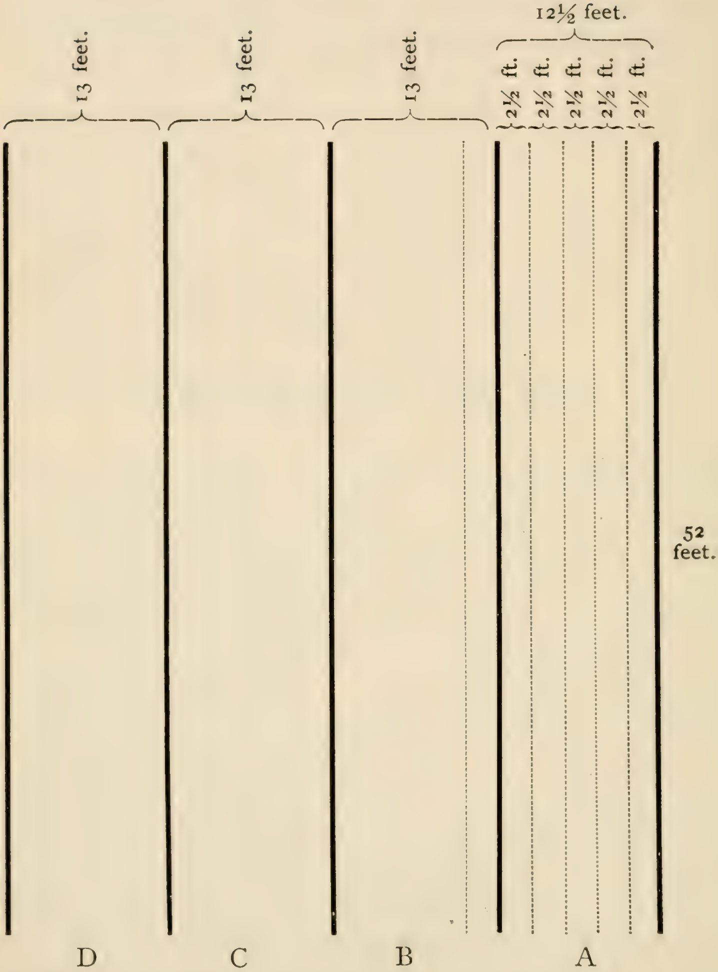
## Sugar Beets—Tillage Experiment.

Enough sugar beet seed will be sent by the Cornell University Experiment Station to plant one-twentieth of an acre. All who wish to co-operate in the experiment are requested to write for seed, which will be distributed as long as the supply lasts.

It is desired that the plats be laid off as follows (See Sugar Beet diagram). Measure off an area 52 feet long and 50 feet wide. In plowing add 2½ feet to each side, making the total area to be plowed 57 by 55 feet. This additional area to be plowed is for the purpose of giving room for tillage on the outside of the outer row. Stake off four plats each 12½ feet wide and 52 feet long. This will provide for four rows of beets to the plat (indicated by the dotted lines) and an extra row between and outside of plats (indicated by solid black lines). These extra rows are not to enter into the experiment and are to be harvested and removed before the regular four rows of the experiment (indicated by dotted lines) are harvested.

The following directions regarding sugar beet culture may be found helpful. An open porous soil, not over sandy, should be selected avoiding heavy clay subsoils or hardpan. While the soil should be fertile yet fresh barn manure should not be applied. Where it is desired to fertilize with barn manure it should be

## SUGAR BEET DIAGRAM.




Four plats 52 feet long; 12½ feet wide, 4 rows to plat, 2½ feet between rows. Area of each plat, $\frac{1}{80}$ acre.

applied and plowed under in the fall. Muck or bottom land soils while they might produce a large amount of beets, yet the percentage of sugar would probably be low. Select well drained upland, loamy soil or one with a fairly porous subsoil. This will enable the beet to expand evenly and produce a smooth, regularly developed root. Plow deep and early, harrow once and then allow the land to remain without being disturbed for a few days. This is to permit whatever weed seed may be in the soil to sprout before planting the beets. Then harrow again thoroughly and if heavy rains have packed the soil, make it loose again with a cultivator or by shallow gang plowing. After fining and pulverizing with the harrow use the roller and follow the roller with a light, fine tooth harrow. This fitting should be done just previous to planting the seeds.

Mark off the rows by stretching a line across the plats, rows to be 2½ feet apart. (See diagram for beets.) The two packages of beet seed sent are sufficient to plant four plats of the dimensions given in the diagram. Planting in this latitude may usually be done from the first to the middle of May. Cover the seed to a depth of about one inch and firm the earth over the rows by means of a rake, leaving it firm but not packed smoothly.

If weeds and grass start before the beets are up then hand work must be resorted to, for it is absolutely essential that the weeds be kept in check and the easiest way to do this is to check them at the start. Should heavy rains cause a surface soil crust to be formed, this crust must be broken up either by using a rake or some light implement similar to a Breed's weeder. As soon as the rows can be followed horse tillage should commence, the implement used being one with many fine teeth (similar to one shown in frontispiece of Cornell Bulletin 130).

This experiment is one of tillage alone. (The fertilizer experiments are described by Dr. Caldwell in Bulletin 129.) As soon as the rows can be followed give all plats tillage with the fine tooth implement. After the first time the tillage of the plats is to vary in frequency. Plats A and C (see diagram) are to receive tillage about every seven days and plats B and D only about every fourteen days, so that every other time all plants

will receive tillage. If weeds or grass appear in the row they must be removed by hand.

Thinning should be done as soon as four leaves are formed. This work must not be delayed until the plants become of considerable size or the roots will so interlace that injury will be done to the ones we wish to leave. In thinning large areas the work is done by chopping out with a hoe, leaving a bunch every nine inches, and then thinning out the bunch by hand. On these small plats the thinning would better all be done by hand. Leave a strong, vigorous plant every nine or ten inches. Press the earth firmly around the plants left but do not hill up. The pressure should not be great enough to injure the cells of the plant.

Harvesting should be done before heavy frost. It also should be done before the tops begin making a second growth. The samples selected to be sent to Cornell University for analysis should be of medium size, not the largest nor smallest but a good average of the lot. The rows indicated in the diagram by the solid black lines should be harvested before the main plats and the beets removed. Then harvest and weigh each plat of four rows. Take as a sample, five average sized beets, put them in a sack and put in the sack with them the record as to culture and yield of the plat. Tie the sack securely and put in a box. In this way take and prepare samples of all the plats, putting in the sack with the sample the record of the plat on which the sample was grown. The following blank form may be used in keeping and reporting the record of the plats:

This is to be returned at the end of the season to CHIEF CLERK, COLLEGE OF AGRICULTURE, Ithaca, N. Y.

Name of Experimenter ..................................

Post Office ..................................

County ..................................

Kind of land . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Previous treatment of land . . . . . . . . . . . . . . . . . . . . . . . . . .

Date of plowing . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Manner of fitting . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Date of planting . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Treatment after planting before plants are up. . . . . . . . . . . .

Date of first tillage of all plats . . . . . . . . . . . . . . . . . . . . . . .

| PLAT A | PLAT B |
| --- | --- |
| (To be tilled about every 7 days.) | (To be tilled one-half as many times as Plat A. About every 14 days.) |
| *Dates of Tilling.* | *Dates of Tilling.* |
| | |
| Date harvested . . . . . . . . . . . . . | Date harvested . . . . . . . . . . . . . |
| Weight of beets . . . . . . . . . . . . . | Weight of beets . . . . . . . . . . . . . |

| PLAT C | PLAT D |
| --- | --- |
| (To be tilled same as A.) | (To be tilled same as B.) |
| *Dates of Tilling.* | *Dates of Tilling.* |
| | |
| Date harvested . . . . . . . . . . . . . | Date harvested . . . . . . . . . . . . . |
| Weight of beets . . . . . . . . . . . . . | Weight of beets . . . . . . . . . . . . . |

I. P. ROBERTS, Director.
L. A. CLINTON, Asst. Agriculturist.

CIRCULAR CONCERNING

# Co-Operative Tillage Experiments.

No. 6.

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Cornell University,
College of Agriculture.

*Ithaca, N. Y., April* 15, 1897.

## Directions for the Application of the Fertilizers and Records to be Made.

Since so many applications have been made for fertilizers to be used in the "Field Experiments," we have limited the size of plats to be experimented upon to $\frac{1}{20}$ of an acre each. We have sent you by freight one large sack containing ten small sacks, each tagged so that you can tell what kind and how much fertilizer each small sack contains.

Pay *no attention* whatever to any printing that may be upon the sacks, but give *strict attention to the tags* that are tied to the bags. The contents of the small sacks are to be applied to the plats as follows:

---

On Plat **K** put contents of one sack containing 10 pounds Muriate of Potash.

On Plat **N** put contents of one sack containing 10 pounds Nitrate of Soda.

On Plat **KN** put contents of one sack containing 10 pounds Muriate of Potash, also contents of one sack containing 10 pounds Nitrate of Soda.

On Plat **P** put contents of one sack containing 20 pounds Superphosphate.

On Plat **KP** put contents of sack containing a mixture of 10 pounds Muriate of Potash and 20 pounds Superphosphate.

On Plat **NKP** put contents of one sack containing 10 pounds Nitrate of Soda, also contents of sack containing a mixture of 10 pounds Muriate of Potash and 20 pounds Superphosphate.

On Plat **NP** put contents of one sack containing 10 pounds Nitrate of Soda, also contents of one sack containing 20 pounds Superphosphate.

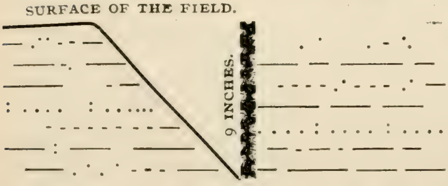
---

Apply the Muriate of Potash and the Superphosphate before the crops are planted and the Nitrate of Soda later. Do not apply the Nitrate of Soda on the plats requiring it until the crops have been planted and have been up about fifteen days; then apply half of the Nitrate as a surface dressing and three weeks later apply the rest and cultivate in.

For corn, or potatoes and such crops that are to be in hills or rows, throw a furrow each way so as to leave a shallow trench. Put the fertilizers (only the Phosphate or Muriate of Potash, or the mixture of the two) in the bottom of this trench; then cover very lightly. A light, fine toothed cultivator may be used for this. This is to prevent the seed from coming in contact with the concentrated fertilizer, which might be injurious to it. Plant the potatoes, or corn, or whatever the crop is, on top of this covered fertilizer and from this point proceed in the ordinary way.

If fertilizers are applied to grapes, berries, etc., in rows, apply along each side of the rows on the surface, and then cultivate in and mix with the surface soil. For any crop that is sown broadcast, apply the fertilizer broadcast and cultivate in. If fine, well rotted stable manure is used on one plat, spread broadcast after land is plowed and cultivate in. If the manure is coarse, spread broadcast and plow it under. If not plowed under it will be more or less in the way all summer.

## Sampling the Soil.




The first thing to do before applying the fertilizer is to get a good average sample of soil from that portion of the field on which the plats are laid out.

Proceed as follows: Sample that portion of the field in from 10 to 15 different places. With a spade with a square end dig a hole, the width of the spade and nine inches deep, leaving one side of the hole vertical and the other side sloping just as in the cut. Clean out all the loose soil at the bottom of the hole; cut off from the vertical side a slice about two inches thick from top

to bottom, the full width of the spade and save this slice to represent one of the partial samples. Pick out all stones larger than ¼ to ½ inch in diameter.

These 10 to 15 small samples are to be mixed together in a large box or on some clean boards. These several partial samples when mixed will make from 1 to 1½ bushels of soil. Mix thoroughly by stirring and shoveling over and over a number of times; then of this *thoroughly* mixed soil take a sample of *three pecks* and put it into the large sack that held the small sacks of fertilizer. Tie it up tightly and keep until further notice. To be of any use for analysis or experiments at the Experiment Station, this sample *must* represent as accurately as possible the whole area to be divided up into the nine plats, before the fertilizers have been applied.

Make a record as complete as possible of the field according to the following plan:

I—*Location of Field.*

- a—Upland.
- b—Lowland. (If lowland, do side hills wash down upon it?)
- c—Hillside, etc.

II—*Character of Soil.*

- a—Sandy.
- b—Gravelly.
- c—Clayey.
- d—Loamy, etc.
- e—How deep is surface soil?
- f—Is there a hard pan; if so, how deep?
- g—Does soil hold moisture, or dry out rapidly?

III—*Fertility of Soil.*

- a—Does soil possess the required amount of plant-food or does it "run down" quickly and need enriching?
- b—Have manures or fertilizers been applied in past years? If so, how often, what kinds and how often, what kinds and how much per acre?

IV—*History of Crops Previous to* 1897.

What crops have been grown and how much yield per acre in past years? In case of cereals give number of bushels of grain and tons of straw or stalks per acre.

V—*History of Crop for* 1897.

Kind of crop grown.

Date of planting.

Date when crop begins to come up on each plat.

Date when crop is about half up on each plat.

Date when crop is practically all up on each plat.

From time to time keep note of any differences that may appear between the various plats.

## SAMPLE RECORD.

I. c—Hillside.

II. b—Gravelly.

III. a—Runs down quickly and needs plant food.

IV. Pasture for eight years, then two years corn—50 bushels corn per acre and three-fourths ton stalks each year, etc.

V. Keep notes of time of planting, etc., as suggested in V under History of Crop for 1897.

## SUGGESTIONS.

The same kind and same amount of seed is to be sown on each of the series of eight or nine plats in the set. Drive stakes in such a way, and so number the plats that there will be no danger of getting the several plats mixed and so cause confusion. It must be remembered that this experiment is to be tried upon the crop planted and not upon an accidental crop of weeds. In no case will the experiment be of value if the weeds are allowed to grow upon the plats. Thorough cultivation is one of the most important features of the field test.

It will be impossible to send an agent to inspect each series of experiments, but if you become very much confused and do not understand the instructions given, let us know and we will try to help you out either by correspondence or by sending an agent to your place.

# APPENDIX II.

*Detailed statement of receipts and expenditures of the Cornell University Agricultural Experiment Station, for the fiscal year ending June 30th, 1897.*

## *RECEIPTS.*

FROM AGRICULTURAL DIVISION.

| | | | | |
|---|---|---|---|---|
| 1896. | | | | |
| Nov. | 25. | Products sold (Farm) . . . . . . . . . . . . | $34 00 | $34 00 |

FROM HORTICULTURAL DIVISION.

| | | | | |
|---|---|---|---|---|
| 1896. | | | | |
| July | 2. | Sundry fruits . . . . . . . . . . . . . . . . . | 4 55 | |
| Nov. | 24. | Sundry fruits . . . . . . . . . . . . . . . | 33 07 | |
| 1897. | | | | |
| Jan. | 6. | Hauling coal . . . . . . . . . . . . . . . . . | 2 96 | |
| " | 6. | Sundry fruits . . . . . . . . . . . . . . . . . | 4 00 | |
| " | 15. | Sundry fruits . . . . . . . . . . . . . . . . . | 20 76 | |
| Feb. | 6. | Sundry fruits . . . . . . . . . . . . . . . . . | 20 55 | |
| June | 23. | Sundry fruits . . . . . . . . . . . . . . . . . | 3 65 | 89 54 |

FROM OFFICE.

| | | | | |
|---|---|---|---|---|
| 1896. | | | | |
| Nov. | 7. | Spray Calendars . . . . . . . . . . . . . . | 2 00 | |
| 1897. | | | | |
| Apr. | 5. | Spray Calendars . . . . . . . . . . . . . . | 33 75 | 35 75 |
| | | Grand Total . . . . . . . . . . . . . | | $159 29 |

## *EXPENDITURES.*

FOR SALARIES.

| | | | |
|---|---|---|---|
| 1896. | | | |
| July | 31. | I. P. Roberts, Director, 1 mo. . . . . . . . . . . . | $125 00 |
| " | 31. | H. H. Wing, Dairyman, 1 mo . . . . . . . . . . . . | 104 24 |
| " | 31. | G. F. Atkinson, Botanist, 1 mo . . . . . . . . . . | 91 74 |
| " | 31. | G. W. Cavanaugh, Assistant Chemist, 1 mo. . . . . . | 83 33 |
| " | 31. | L. A. Clinton, Assistant Agriculturist, 1 mo . . . . . | 83 33 |
| " | 31. | E. A. Butler, Clerk, 1 mo . . . . . . . . . . . . . | 50 00 |
| Aug | 31. | I. P. Roberts, Director, 1 mo. . . . . . . . . . . . | 125 00 |
| " | 31. | H. H. Wing, Dairyman, 1 mo . . . . . . . . . . . . | 104 24 |
| " | 31. | G. F. Atkinson, Botanist, 1 mo . . . . . . . . . . | 91 74 |
| " | 31. | G. W. Cavanaugh, Assistant Chemist, 1 mo. . . . . . | 83 33 |
| " | 31. | L. A. Clinton, Assistant Agriculturist, 1 mo. . . . . . | 83 33 |
| Sept. | 30. | I. P. Roberts, Director, 1 mo. . . . . . . . . . . . | 125 00 |
| " | 30. | H. H. Wing, Dairyman, 1 mo . . . . . . . . . . . . | 104 00 |
| " | 30. | G. F. Atkinson, Botanist, 1 mo. . . . . . . . . . . | 91 74 |
| | | Amount carried forward . . . . . . . . . . . | $1,346 02 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $1,346 02 |
| Sept. | 30. | G. W. Cavanaugh, Assistant Chemist, 1 mo. | 83 33 |
| " | 30. | L. A. Clinton, Assistant Agriculturist, 1 mo. | 83 33 |
| " | 30. | E. A. Butler, Clerk, 1 mo | 50 00 |
| Oct. | 31. | I. P. Roberts, Director, 1 mo | 125 00 |
| " | 31. | L. H. Bailey, Horticulturist, 1 mo | 166 66 |
| " | 31. | H. H. Wing, Dairyman, 1 mo | 104 16 |
| " | 31. | M. V. Slingerland, Assistant Entomologist, 1 mo | 125 00 |
| " | 31. | G. F. Atkinson, Botanist, 1 mo | 91 66 |
| " | 31. | G. W. Cavanaugh, Assistant Chemist, 1 mo. | 83 33 |
| " | 31. | L. A. Clinton, Assistant Agriculturist, 1 mo. | 83 33 |
| Nov. | 30. | I. P. Roberts, Director, 1 mo | 125 00 |
| " | 30. | L. H. Bailey, Horticulturist, 1 mo | 166 66 |
| " | 30. | H. H. Wing, Dairyman, 1 mo | 104 16 |
| " | 30. | M. V. Slingerland, Assistant Entomologist, 1 mo | 125 00 |
| " | 30. | G. F. Atkinson, Botanist, 1 mo. | 91 66 |
| " | 30. | G. W. Cavanaugh, Assistant Chemist, 1 mo | 83 33 |
| " | 30. | L. A. Clinton, Assistant Agriculturist, 1 mo | 83 33 |
| " | 30. | E. A. Butler, Clerk, 1 mo | 50 00 |
| Dec. | 31. | I. P. Roberts, Director, 1 mo | 125 00 |
| " | 31. | L. H. Bailey, Horticulturist, 1 mo | 166 66 |
| " | 31. | H. H. Wing, Dairyman, 1 mo | 104 16 |
| " | 31. | M. V. Slingerland, Assistant Entomologist, 1 mo | 125 00 |
| " | 31. | G. F. Atkinson, Botanist, 1 mo | 66 67 |
| " | 31. | G. W. Cavanaugh, Assistant Chemist, 1 mo. | 83 33 |
| " | 31. | L. A. Clinton, Assistant Agriculturist, 1 mo. | 83 33 |
| 1897. | | | |
| Jan. | 31. | I. P. Roberts, Director, 1 mo. | $125 00 |
| " | 31. | L. H. Bailey, Horticulturist, 1 mo | 166 66 |
| " | 31. | H. H. Wing, Dairyman, 1 mo | 104 16 |
| " | 31. | M. V. Slingerland, Assistant Entomologist, 1 mo | 125 00 |
| " | 31. | G. F. Atkinson, Botanist, 1 mo | 83 33 |
| " | 31. | G. W. Cavanaugh, Assistant Chemist, 1 mo. | 83 33 |
| " | 31. | L. A. Clinton, Assistant Agriculturist, 1 mo. | 83 33 |
| " | 31. | E. A. Butler, Clerk, 1 mo | 50 00 |
| Feb. | 28. | I. P. Roberts, Director, 1 mo | 125 00 |
| " | 28. | L. H. Bailey, Horticulturist, 1 mo | 166 66 |
| " | 28. | H. H. Wing, Dairyman, 1 mo | 104 16 |
| " | 28. | M. V. Slingerland, Assistant Entomologist, 1 mo | 125 00 |
| " | 28. | G. F. Atkinson, Botanist, 1 mo | 83 33 |
| " | 28. | G. W. Cavanaugh, Assistant Chemist, 1 mo. | 83 33 |
| " | 28. | L. A. Clinton, Assistant Agriculturist, 1 mo. | 83 33 |
| Mar. | 31. | I. P. Roberts, Director, 1 mo. | 125 00 |
| " | 31. | L. H. Bailey, Horticulturist, 1 mo | 166 66 |
| " | 31. | H. H. Wing, Dairyman, 1 mo | 104 16 |
| " | 31. | M. V. Slingerland, Assistant Entomologist, 1 mo | 125 00 |
| " | 31. | G. F. Atkinson, Botanist, 1 mo | 83 33 |
| " | 31. | G. W. Cavanaugh, Assistant Chemist, 1 mo | 83 33 |
| " | 31. | L. A. Clinton, Assistant Agriculturist, 1 mo | 83 33 |
| Apr. | 30. | I. P. Roberts, Director, 1 mo | 125 00 |
| " | 30. | L. H. Bailey, Horticulturist, 1 mo | 125 00 |
| " | 30. | H. H. Wing, Dairyman, 1 mo | 52 08 |
| " | 30. | G. F. Atkinson, Botanist, 1 mo | 83 33 |
| " | 30. | G. W. Cavanaugh, Assistant Chemist, 1 mo | 83 33 |
| | | Amount carried forward | $6,756 28 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $6,756 28 |
| Apr. | 30. | L. A. Clinton, Assistant Agriculturist, 1 mo | 83 33 |
| " | 30. | E. A. Butler, Clerk, 1 mo | 50 00 |
| May | 31. | I. P. Roberts, Director, 1 mo. | 125 00 |
| " | 31. | L. H. Bailey, Horticulturist, 1 mo | 125 00 |
| " | 31. | H. H. Wing, Dairyman, 1 mo | 52 08 |
| " | 31. | G. F. Atkinson, Botanist, 1 mo | 83 33 |
| " | 31. | G. W. Cavanaugh, Assistant Chemist, 1 mo | 83 33 |
| " | 31. | L. A. Clinton, Assistant Agriculturist, 1 mo | 83 33 |
| " | 31. | E. A. Butler, Clerk, 1 mo | 50 00 |
| June | 30. | I. P. Roberts, Director, 1 mo | 125 00 |
| " | 30. | L. H. Bailey, Horticulturist, 1 mo | 125 00 |
| " | 30. | H. H. Wing, Dairyman, 1 mo | 52 08 |
| " | 30. | G. F. Atkinson, Botanist, 1 mo | 83 33 |
| " | 30. | G. W. Cavanaugh, Assistant Chemist, 1 mo | 83 33 |
| " | 30. | L. A. Clinton, Assistant Agriculturist, 1 mo | 83 33 |
| | | Total for Salaries | $8,043 75 |

FOR PRINTING.

| | | | |
|---|---|---|---|
| 1896. | | | |
| Aug. | 31. | W. F. Humphrey, 12,000 copies Bulletin No. 118 | $48 80 |
| " | 31. | W. F. Humphrey, 6 aditional pages Bulletin No. 117, 12,000 | 38 40 |
| " | 31. | U. S. Express Co., Expressage | 25 |
| Sept. | 3. | L. V. R. R. Co., Freight | 1 12 |
| " | 3 | L. V. R. R. Co., Freight | 1 07 |
| " | 4. | Andrus & Church, 5,000 Cards Printed | 7 25 |
| " | 8. | L. V. R. R. Co., Freight | 2 76 |
| Oct. | 12. | Western Union Telegraph Co., Telegram | 25 |
| Nov. | 7. | L. V. R. R. Co., Freight | 56 |
| " | 19. | U. S. P. O., Stamps | 10 00 |
| Dec. | 7. | U. S. Express Co., Expressage | 45 |
| " | 15. | U. S. Express Co., Expressage | 25 |
| 1897. | | | |
| Jan. | 27. | U. S. Express Co., Expressage | 80 |
| Feb. | 2. | U. S. Express Co , Expressage | 1 50 |
| " | 10. | U. S. Express Co., Expressage | 30 |
| " | 16. | L. V. R. R. Co., Freight | 11 17 |
| " | 16. | L. V. R. R. Co , Freight and Cartage | 66 |
| " | 16. | L. V. R. R. Co., Freight and Cartage | 2 48 |
| " | 17. | U. S. Express Co., Expressage | 65 |
| " | 20. | U. S. Express Co., Expressage | 65 |
| " | 22. | U. S. Express Co., Expressage | 65 |
| " | 25. | Franklin Engraving Co., 5 half-tone Cuts | 19 75 |
| " | 25. | Franklin Engraving Co., 5 half-tone Cuts | 18 00 |
| " | 26. | U. S. Express Co., Expressage | 1 05 |
| Mar. | 31. | J. H. McFarland Co., 1 half-tone Cut | 3 50 |
| " | 31. | H. T. Anthony & Co., 1,500 Negative Prints | 3 95 |
| Apr. | 8. | L. V. R. R. Co., Freight | 93 |
| " | 14. | W. F. Humphrey, 20,000 copies Bulletin No. 130 | 162 20 |
| " | 20. | U. S. Express Co., Expressage | 70 |
| " | 24. | C. W. Sims, Labor | 5 00 |
| May | 3. | L. V. R. R. Co., Freight and Cartage | 61 |
| " | 10. | L. V. R. R. Co., Freight and Cartage | 1 07 |
| | | Amount carried forward | $346 78 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $346 78 |
| May | 10. | L. V. R. R. Co., Freight and Cartage | 1 34 |
| " | 25. | L. V. R. R. Co., Freight and Cartage | 3 63 |
| | | Total for Printing | $351 75 |

FOR OFFICE EXPENSES.

| | | | |
|---|---|---|---|
| 1896. | | | |
| July | 1. | E. S. Tichenor, Furniture | $13 00 |
| " | 7. | E. A. Butler, Supplies | 65 |
| " | 13. | U. S. Express Co., Expressage | 55 |
| " | 13. | Andrus & Church, Stationery and Supplies | 3 90 |
| " | 13. | M. A. Adsitt, Stationery | 2 50 |
| " | 13. | Lovejoy Co , Expressage on Cut | 25 |
| " | 29. | L. V. Maloney, Labor | 40 50 |
| " | 30. | Treman, King & Co., Supplies | 1 79 |
| " | 30. | Western Union Telegraph Co., Telegram | 50 |
| Aug. | 1. | Andrus & Church, Stationery | 1 50 |
| " | 3. | Western Union Telegraph Co., Telegrams | 16 50 |
| " | 20. | Lovejoy Co., 1 half-tone Cut and Postage | 5 09 |
| " | 20. | Andrus & Church, 1 doz. Pencils | 40 |
| " | 20. | M. A. Adsitt, Typewriter Ribbon | 1 00 |
| " | 20. | Ithaca *Journal*, Envelopes | 18 75 |
| " | 20. | U. S. P. O., Stamps | 10 00 |
| " | 31. | L. V. Maloney, Labor | 39 00 |
| " | 31. | W. C. Bell, Labor | 15 00 |
| Sept. | 4. | Treman, King & Co., Supplies | 90 |
| " | 8. | M. A. Adsitt, Typewriter Ribbon and Stationery | 2 30 |
| " | 15. | U. S. P. O., Stamps | 10 00 |
| " | 17. | Andrus & Church, Mucilage | 1 00 |
| " | 21. | Rand, McNally Co., Atlas (2 Vols.) | 28 50 |
| " | 25. | W. C. Bell, Labor | 4 80 |
| " | 25. | Andrus & Church, Rubber Bands | 25 |
| " | 30. | L. V. Maloney, Labor | 39 00 |
| " | 30. | Andrus & Church, Ink and Pins | 20 |
| " | 30. | Andrus & Church, Scrap Book | 80 |
| Oct. | 6. | Andrus & Church, Letter Opener | 35 |
| " | 16. | E. G. Hance, Cartage | 50 |
| " | 19. | Andrus & Church, Sundry Supplies | 1 67 |
| " | 19. | Andrus & Church, Day Book and Ledger | 3 30 |
| " | 23. | Andrus & Church, Reading Glass | 60 |
| " | 28. | J. M. Hovey, Labor | 1 60 |
| " | 29. | Andrus & Church, Bristol-board | 48 |
| " | 31. | L. V. Maloney, Labor | 40 50 |
| " | 31. | John Gilmore, Labor | 75 |
| " | 31. | C. B. Tailby, Labor | 2 85 |
| " | 31. | G. W. Tailby, Labor | 4 10 |
| Nov. | 5. | M. A. Adsitt, Letter Book and Delivery | 2 90 |
| " | 7. | U. S. P. O., Stamps | 10 00 |
| " | 11. | U. S. Express Co., Expressage | 60 |
| " | 17. | Wm. J. Campbell, Books | 1 50 |
| " | 17. | M. A. Adsitt, Stationery | 2 20 |
| " | 17. | Andrus & Church, Supplies | 20 |
| " | 18. | M. A. Adsitt, Supplies | 1 10 |
| | | Amount carried forward | $333 83 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $333 83 |
| Nov. | 21. | W. J. Campbell, Book | 1 25 |
| " | 24. | A. B. Brooks, Sundry Supplies | 2 25 |
| " | 30. | L. V. Maloney, Labor | 37 50 |
| Dec. | 7. | Andrus & Church, Stationery | 2 23 |
| " | 8. | Ithaca Plumbing Co., 6 Chimneys | 60 |
| " | 15. | Andrus & Church, 5,000 printed Letter Heads | 17 50 |
| " | 22 | B. F. White, Photographs | 25 05 |
| " | 23. | U. S. P. O., Stamps | 10 00 |
| " | 29 | L. V. Maloney, Labor | 40 50 |
| " | 30. | G. W. Tailby, Labor | 70 |
| " | 30. | C. B. Tailby, Labor | 33 |
| " | 30. | A. B. Kennedy, Repairing Clock | 1 20 |
| 1897. | | | |
| Jan. | 5. | Western Union Telegraph Co., Telegram | 33 |
| " | 9. | Andrus & Church, Stationery | 2 85 |
| " | 12. | Ithaca Gas Co., Gas | 2 08 |
| " | 12. | Treman, King & Co., Supplies | 1 45 |
| " | 15. | U. S. P. O., Stamps | 10 00 |
| " | 15. | Lovejoy Co., Cuts and Engraving | 2 28 |
| " | 15. | I. P. Roberts, Traveling Expenses | 2 25 |
| " | 15. | Andrus & Church, Cardboard | 1 20 |
| " | 16. | L. V. R. R. Co., Freight and Cartage | 6 74 |
| " | 19. | A. A. A. C. & E. S., Membership Fee | 10 00 |
| " | 26. | Andrus & Church, Printing 300 Postal Cards | 75 |
| " | 26. | U. S. Express Co., Expressage | 1 50 |
| " | 30. | L. V. Maloney, Labor | 39 00 |
| Feb. | 5. | Western Union Telegraph Co., Telegrams | 1 50 |
| " | 5. | W. J. Harris, Labor | 1 00 |
| " | 11. | John Gilmore, Labor | 1 65 |
| " | 13. | U. S. Express Co., Expressage | 80 |
| " | 15. | L. V. R. R. Co., Freight and Cartage | 62 |
| " | 18. | U. S. Express Co., Expressage | 40 |
| " | 20. | Ithaca Gas Co., Gas | 1 12 |
| " | 22. | W. H. Carver, Pens | 1 50 |
| " | 23. | U. S. Express Co., Expressage | 55 |
| " | 24. | E. G. Hance, Cartage | 85 |
| " | 25. | Andrus & Church, Supplies | 1 75 |
| " | 25. | Andrus & Church, Stationery | 2 85 |
| " | 26. | L. V. Maloney, Labor | 36 00 |
| " | 27. | C. B. Tailby, Labor | 2 79 |
| " | 27. | G. W. Tailby, Labor | 3 64 |
| " | 27. | John Gilmore, Labor | 4 05 |
| Mar. | 6. | M. A. Adsitt, Supplies | 2 20 |
| " | 7. | L. V. R. R. Co., Freight and Cartage | 5 50 |
| " | 8. | M. V. Slingerland, Traveling Expenses | 27 95 |
| " | 17. | Ithaca Gas Co., Gas | 80 |
| " | 17. | Andrus & Church, Rule | 50 |
| " | 17. | Ithaca Stamp Co., Rubber Stamp | 2 50 |
| " | 18. | W. J. Harris, Sign | 5 50 |
| " | 18. | I. P. Roberts, Traveling Expenses | 16 19 |
| " | 29. | Cornell Co-op. Society, Supplies | 15 03 |
| " | 29. | L. V. Maloney, Labor | 40 50 |
| " | 31. | G. W. Tailby, Labor | 5 12 |
| " | 31. | C. B. Tailby, Labor | 3 75 |
| | | Amount carried forward | $739 98 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $739 98 |
| Mar. | 31. | M. A. Adsitt, Sundry Supplies and Stationery | 6 55 |
| Apr. | 1. | John Gilmore, Labor | 14 25 |
| " | 5. | U. S. P. O., Stamps | 10 00 |
| " | 12. | Andrus & Church, Supplies | 30 |
| " | 21. | Carrie Gaylord, Labor | 9 10 |
| " | 24. | U. S. P. O., Stamps | 10 00 |
| " | 30. | L. V. Maloney, Labor | 39 00 |
| " | 30. | G. W. Tailby, Labor | 8 76 |
| " | 30. | C. B. Tailby, Labor | 5 00 |
| " | 30. | L. E. Shanks, Labor | 2 85 |
| May | 1. | C. H. Howes, Camera and Fixtures | 34 90 |
| " | 3. | John Gilmore, Labor | 12 60 |
| " | 4. | S. J. Druskin, Labor | 1 50 |
| " | 18. | Ithaca Gas Co., Gas | 64 |
| " | 20. | U. S. P. O., Stamps | 10 00 |
| " | 22. | Andrus & Church, Stationery | 3 75 |
| " | 29. | L. V. Maloney, Labor | 39 50 |
| June | 1. | Wm. McGraime, Labor | 1 00 |
| " | 3. | Andrus & Church, Stationery | 1 75 |
| " | 9. | M. A. Adsitt, Note Books | 1 50 |
| " | 12. | Co-op. Society, Sundry Supplies | 5 93 |
| " | 14. | Lucy Custis, Labor | 10 88 |
| " | 15. | Carter Ink Co., 4 Ribbons | 4 50 |
| " | 19. | Andrus & Church, Supplies | 40 |
| " | 19. | M. Gaylord, Labor | 3 45 |
| " | 23. | M. A. Adsitt, Stationery | 1 20 |
| " | 23. | John Gilmore, Labor | 8 40 |
| " | 29. | L. V. Maloney, Labor | 38 50 |
| " | 30. | Andrus & Church, 2 M Envelopes | 2 90 |
| | | Total for Office Expenses | $1,029 09 |

FOR AGRICULTURAL DIVISION.

| | | | |
|---|---|---|---|
| 1896. | | | |
| July | 17. | White & Burdick, Chemicals | 1 80 |
| " | 20. | Andrus & Church, Sundry Supplies | 1 85 |
| " | 21. | U. S. Express Co., Expressage | 90 |
| " | 24. | Andrus & Church, Supplies | 12 75 |
| " | 29. | Treman, King & Co., Supplies | 4 80 |
| " | 31. | B. F. White, Photographs | 10 50 |
| Aug. | 3. | Fuertes Pharmacy, Chemicals | 8 06 |
| " | 20. | Driscoll Bros. & Co., Lime | 1 50 |
| " | 20. | J. W. Hills, Lantern Slides | 18 50 |
| " | 31. | A. T. Stout, Labor | 40 |
| " | 31. | C. B. Tailby, Labor | 1 60 |
| " | 31. | G. W. Tailby, Labor | 3 01 |
| " | 31. | C. W. Sims, Labor | 29 70 |
| " | 31. | H. W. Badger, Labor | 13 24 |
| " | 31. | J. Shimada, Labor | 31 63 |
| Sept. | 3. | L. V. R. R. Co., Freight | 2 71 |
| " | 3. | D. L. & W. R. R. Co., Freight and Cartage | 60 |
| " | 8. | O. A. C. Agr. College, Wheat | 2 90 |
| " | 14. | U. S. P. O., Stamped Envelopes | 21 60 |
| " | 26. | L. V. R. R. Co., Freight and Cartage | 4 18 |
| " | 30. | A. T. Stout, Labor | 2 88 |
| | | Amount carried forward | $175 11 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $175 11 |
| Sept. | 30. | L. Harrington, Labor | 10 47 |
| " | 30. | C. B. Tailby, Labor | 2 70 |
| " | 30. | G. W. Tailby, Labor | 2 73 |
| Oct. | 3. | U. S. Express Co., Expressage | 75 |
| " | 19. | White & Burdick, Chemicals | 2 55 |
| " | 24. | L. V. R. R. Co., Freight | 45 |
| " | 29 | Treman, King & Co., Tape Line | 1 25 |
| " | 30. | Syracuse Pottery Co., Pots and Saucers | 9 00 |
| " | 31. | G. S. Hall, Pig | 15 00 |
| " | 31. | L. Harrington, Labor | 21 00 |
| " | 31. | S. Raub, Labor | 16 50 |
| " | 31. | A. J. Briggs, Labor | 6 15 |
| " | 31. | John Gilmore, Labor | 4 58 |
| " | 31. | J. Shimada, Labor | 3 75 |
| " | 31. | National Express Co., Expressage | 3 05 |
| Nov. | 5 | Tremen, King & Co., Twine | 25 |
| " | 5. | L. Roesch, Grape Cuttings | 1 07 |
| " | 7. | L. V. R. R. Co., Freight and Cartage | 1 18 |
| " | 9. | Enz & Miller, Stationery | 2 37 |
| " | 28. | L. V. R. R. Co., Freight and Cartage | 1 59 |
| " | 30. | Theodore VanAtta, Labor | 35 87 |
| " | 30. | S. Raub, Labor | 21 75 |
| " | 30. | L. Harrington, Labor | 21 00 |
| " | 30. | A. J Briggs, Labor | 7 20 |
| " | 30. | G. W. Tailby, Labor | 1 95 |
| " | 30. | C. B. Tailby, Labor | 1 53 |
| " | 30. | John Gilmore, Labor | 4 95 |
| Dec. | 1. | U. S. Express Co., Expressage | 1 60 |
| " | 7. | Andrus & Church, 1 M Letter Heads | 4 75 |
| " | 7. | I. P. Roberts, Traveling Expenses | 17 70 |
| " | 8. | L. V. R. R. Co., Freight and Cartage | 1 12 |
| " | 14. | Protection Manufacturing Co., Chemicals | 7 50 |
| " | 14. | Cotte & Gliemann, Palm Nut Meal | 12 59 |
| " | 16. | J. Slight, Potatoes | 3 30 |
| " | 16. | Tice & Lynch, Ocean Freight and Cartage | 12 20 |
| " | 29. | J. Miller, Potatoes | 3 95 |
| " | 29. | E. McGillivray, Dry Plates | 1 80 |
| 1897. | | | |
| Jan. | 1. | J. E. Slight, Potatoes | 4 41 |
| " | 6. | Fuestes Pharmacy, Chemicals | 3 75 |
| " | 12. | L. V. R. R. Co., Freight and Cartage | 4 30 |
| " | 23. | J. H. Van Ness, Artichokes | 50 |
| " | 30. | G. W. Tailby, Labor | 1 72 |
| " | 30. | A. J. Briggs, Labor | 3 90 |
| Feb. | 27. | A. J. Briggs, Labor | 4 20 |
| " | 27. | M. Raub, Labor | 3 00 |
| Mar. | 4. | George Small, Lumber | 1 24 |
| " | 11. | M. F. Webster, Labor | 1 00 |
| " | 13. | D. M. Osborne & Co., Casting | 25 |
| Apr. | 14. | H. C. Troy, Labor | 16 70 |
| " | 26. | U. S. Express Co., Expressage | 45 |
| " | 27. | Treman, King & Co., Rubber Belting | 1 43 |
| " | 27. | J. M. Thorburn & Co., Grass Seed | 1 17 |
| " | 29. | U. S. Express Co., Expressage | 70 |
| | | Amount carried forward | $490 98 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $490 98 |
| Apr. | 30. | L. C. Anderson, Labor | 6 40 |
| " | 30. | John Gilmore, Labor | 75 |
| May | 1. | Campbell & Wood, Brick | 39 00 |
| " | 1. | Treman, King & Co., Supplies | 60 |
| " | 1. | L. J. Farmer, Strawberry Plants | 2 25 |
| " | 1. | L. F. Noxon, Garden Seeds | 3 80 |
| " | 10. | L. V. R. R. Co., Freight and Cartage | 1 36 |
| " | 24. | H. C. Troy, Labor | 16 60 |
| June | 3. | Peter Henderson, Garden Seeds | 5 10 |
| " | 3. | Godfrey & Gilbert, Repairs | 6 72 |
| " | 7. | Horace Atwood, Labor | 32 00 |
| " | 8. | L. Anderson, Labor | 16 00 |
| " | 12. | W. C. Wisser, Fancy Cheese | 6 68 |
| " | 15. | L. F. Noxon, Seeds | 12 95 |
| " | 18. | F. Cramer, Labor | 7 50 |
| " | 21. | B. F. White, Photographs | 7 33 |
| " | 24. | G. R. Chamberlain, Labor | 1 00 |
| " | 30. | Theodore VanAtta, Labor | 37 00 |
| | | Total for Agricultural Division | $694 02 |

FOR HORTICULTURAL DIVISION.

| | | | |
|---|---|---|---|
| 1896. | | | |
| July | 6. | D. Gallagher, Labor | 2 85 |
| " | 6. | William Cunningham, Labor | 2 85 |
| " | 17. | A. A. Terrill & Co., Repairing Roof of Barn | 45 64 |
| " | 18. | Ira Grover, Hay | 11 28 |
| " | 21. | W. H. Morgan, Labor | 3 48 |
| " | 21. | C. T. Stephens, Seeds | 1 90 |
| " | 21. | Peter Henderson, Seeds | 20 |
| " | 21. | Pitcher & Manda, Seeds | 15 |
| Aug. | 1. | Ira Grover, Labor | 37 00 |
| Sept. | 2. | Ira Grover, Labor | 37 50 |
| " | 16. | M. G. Kains, Traveling Expenses | 7 79 |
| " | 16. | C. E. Hunn, Traveling Expenses | 12 50 |
| " | 16. | W. Miller, Traveling Expenses | 17 10 |
| " | 26. | Peter Henderson, Seeds | 50 |
| " | 26. | D. M. Ferry & Co., Seeds | 22 |
| " | 26. | W. W. Rawson & Co., Seeds | 25 |
| " | 26. | W. A. Manda, Seeds | 10 |
| " | 26. | J. C. Vaughn, Seeds | 25 |
| Oct. | 1. | Ira Grover, Labor | 37 50 |
| " | 3. | F. Ellis, Hay | 12 53 |
| " | 19. | H. A. Dreer, Mushroom Spawn | 6 50 |
| " | 19. | Hawkins & Todd, Dry Goods | 16 19 |
| " | 19. | Slocum & Taber, Sundry Supplies | 13 38 |
| " | 19. | C. T. Stephens, Grass Seed | 1 35 |
| " | 19. | A. J. Calkins, Harness Repairs | 2 20 |
| " | 19. | Fall Creek Milling Co., Feed and Bran | 16 71 |
| " | 19. | White & Burdick, Chemicals | 4 65 |
| " | 19. | Andrus & Church, Sundry Supplies | 19 75 |
| " | 19. | J. M. Thorburn & Co., Seeds | 6 00 |
| " | 21. | Burns Bros., Horse Shoeing | 11 15 |
| " | 23. | Fall Creek Milling Co., Feed and Bran | 7 68 |
| | | Amount carried forward | $337 15 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $337 15 |
| Oct. | 23. | C. J. Rumsey, Sundry Supplies | 57 51 |
| " | 26. | J. M. Thorburn & Co., Seeds | 3 00 |
| " | 27. | H. Cannell & Sons, Seeds | 71 |
| " | 27. | L. Roesch, Seeds | 65 |
| Nov. | 2. | Ira Grover, Labor | 37 50 |
| " | 4. | L. V. R. R. Co., Freight and Cartage | 1 66 |
| " | 5. | Burns Bros., Horse Shoeing | 1 50 |
| " | 17. | E. & H. T. Anthony, Photographic Supplies | 5 56 |
| " | 28. | W. B. Schutt, Hay | 10 39 |
| " | 30. | U. S. Dept. Agr , 200 Index Cards | 2 00 |
| Dec. | 2. | Ira Grover, Labor | 37 50 |
| " | 7. | Dammann & Co., Seeds | 33 |
| " | 10. | E. & H. T. Anthony, Chemicals | 1 77 |
| " | 12. | L. V. R. R. Co., Freight and Cartage | 1 47 |
| 1897. | | | |
| Jan. | 9. | Rothschild Bros., Supplies | 90 |
| " | 9. | Ira Grover, Labor | 37 50 |
| " | 9. | J. B. Freese, Straw | 10 55 |
| " | 12. | J. B. Todd, Chemicals | 1 95 |
| " | 16. | J. Reidy & Co., Supplies | 13 33 |
| " | 23. | Syracuse Supply Co., Steel Stamp | 2 50 |
| " | 23. | Burns Bros., Horse Shoeing | 2 30 |
| " | 23. | J. A Salzer & Co., Seeds | 50 |
| " | 26. | J. M. Thorburn & Co., Seeds | 3 98 |
| " | 26. | Eimer & Amend, Chemicals | 6 03 |
| " | 26. | Pritchard & Son, Wagon Repairs | 11 95 |
| " | 29. | Salem Twist, Team | 200 00 |
| Feb. | 2. | Ira Grover, Labor | 37 50 |
| " | 13. | George Small, Lumber | 10 03 |
| " | 16. | L. V. R. R. Co., Freight and Cartage | 2 14 |
| " | 18. | D. L. & W. R. R. Co., Freight and Cartage | 45 |
| " | 20. | C. U. Repair Dept., Repairs | 9 00 |
| " | 25. | Burns Bros., Horse Shoeing | 4 70 |
| " | 25. | J. M. Thorburn & Co., Seeds | 86 |
| " | 25. | Fall Creek Milling Co., Feed and Bran | 7 45 |
| " | 25. | A. A. Ricksecker, Plants | 1 10 |
| " | 25. | Driscoll Bros. & Co., Building Material | 7 27 |
| " | 25. | J. B. Lang, Repairing Engine | 1 56 |
| " | 25. | State Veterinary College, Medicine | 1 10 |
| " | 26. | O. Mitchell, Oats | 12 89 |
| " | 26. | E. Prestwick, Hay | 27 97 |
| Mar. | 2. | U. S. Dept. Agr., 200 Index Cards | 2 00 |
| " | 3. | Ira Grover, Labor | 37 50 |
| " | 4. | Rubber Stamp Works, Stamp | 78 |
| " | 4. | Burns Bros., Horse Shoeing | 2 40 |
| " | 4. | Syracuse Pottery Co., Crockery | 4 40 |
| " | 17. | Teed & Trench, Horse Blankets | 5 00 |
| " | 20. | L. V. R. R. Co., Freight and Cartage | 1 46 |
| Apr. | 3. | Ira Grover, Labor | 37 50 |
| " | 6. | D. L. & W. R. R. Co., Freight | 55 |
| " | 14. | B. Chase, Pot Labels | 3 30 |
| " | 17. | R. R. Co., Freight and Cartage | 1 24 |
| " | 20. | Scoville & Adams, Supplies | 8 02 |
| " | 20. | U. S. Express Co., Expressage | 60 |
| | | Amount carried forward | $1,018 96 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $1,018 96 |
| May | 1. | C. J. Rumsey & Co., Supplies | 41 90 |
| " | 3. | Ira Grover, Labor | 37 50 |
| " | 4. | J. M. Preswick, Oats | 23 13 |
| " | 5. | Driscoll Bros. & Co., Cement | 1 00 |
| " | 10. | U. S. Express Co., Expressage | 1 20 |
| " | 10. | L. V. R. R. Co., Freight and Cartage | 2 60 |
| " | 18. | U. S. Express Co., Expressage | 35 |
| June | 2. | Ira Grover, Labor | 37 50 |
| " | 3. | F. E. Britton, Labor | 90 |
| " | 3. | C. J. Rumsey, Glass | 17 40 |
| " | 21. | C. J. Rumsey, Supplies | 86 60 |
| " | 23. | C. J. Rumsey, Supplies | 28 66 |
| " | 23. | A. J. Calkins, Harness Repairs | 2 20 |
| " | 30. | Ira Grover, Labor | 37 50 |
| " | 30. | Andrus & Church, Stationery | 5 75 |
| | | Total for Horticultural Division | $1,343 15 |

FOR CHEMICAL DIVISION.

| | | | |
|---|---|---|---|
| 1896. | | | |
| July | 3. | J. K. Haywood, Labor | 31 35 |
| " | 20. | Fuertes Pharmacy, Chemicals | 66 |
| Aug. | 1. | J. K. Haywood, Labor | 56 25 |
| Sept. | 3. | J. K. Haywood, Labor | 54 90 |
| Oct. | 2. | Bush and Dean, Supplies | 75 |
| " | 3. | J. K. Haywood, Labor | 42 45 |
| " | 19. | E. B. Holcomb, Labor | 4 50 |
| " | 31. | J. K. Haywood, Labor | 22 05 |
| " | 31. | J. P. Troy, Towels | 75 |
| Nov. | 27. | G. C. Caldwell, Traveling Expenses | 23 35 |
| Dec. | 11. | Treman, King & Co., Belting | 75 |
| 1897. | | | |
| Jan. | 9. | Treman, King & Co., Supplies | 46 35 |
| Feb. | 1. | B. S. Cushman, Labor | 8 40 |
| Mar. | 24. | B. S. Cu-hman, Labor | 6 00 |
| June | 14. | Cornell Univ. Chemical Dept., Supplies | 144 45 |
| | | Total for Chemical Division | $442 96 |

FOR BOTANICAL DIVISION.

| | | | |
|---|---|---|---|
| 1896. | | | |
| July | 1. | White & Burdick, Supplies | 2 70 |
| " | 7. | G. E. Stechert, Publications | 22 71 |
| " | 7. | Reed & Montgomery, Book Binding | 1 00 |
| " | 17. | Dr. C. L. Anderson, Collection of Plants | 10 00 |
| " | 27. | U. S. Express Co., Expressage | 25 |
| " | 29. | C. F. Libbie & Co., Supplies | 5 25 |
| " | 29. | Andrus & Church, Rubber Bands | 15 |
| " | 29. | Cambridge Supply Co., Botanical Case | 15 00 |
| " | 29. | Platt Drug Co., Chemicals | 1 25 |
| Aug. | 10. | National Express Co., Expressage | 35 |
| Sept. | 14. | U. S. Express Co., Expressage | 25 |
| Oct. | 2. | Richards & Co., Chemicals | 7 10 |
| | | Amount carried forward, | $66 01 |

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|---|---|---|---|
| | | Amount brought forward | $66 01 |
| Oct. | 2. | G. E. Stechert, Publications | 1 74 |
| " | 2. | Andrus & Church, Stationery | 6 25 |
| " | 2. | White & Burdick, Chemicals | 5 18 |
| " | 2. | Bush & Dean, Muslin | 1 15 |
| " | 2. | Bausch & Lomb, Microscopic Supplies | 7 05 |
| " | 2. | Eimer & Amend, Microscopic Supplies | 10 00 |
| " | 6. | National Express Co., Expressage | 35 |
| Nov. | 11. | U. S. Express Co., Expressage | 80 |
| " | 17. | Rochester Optical Co., Photographic Supplies | 29 88 |
| " | 17. | J. Carbutt, Microscopic Supplies | 4 25 |
| " | 17. | Bausch & Lomb, Camera | 3 00 |
| " | 18. | Bertha Stoneman, Labor | 9 40 |
| Dec. | 7. | Dr. C. L. Anderson, Collection of Plants | 10 00 |
| " | 7 | E. Steigler & Co., Models | 45 53 |
| " | 7. | Eimer & Amend, Chemicals | 4 60 |
| " | 10. | Rothschild Bros., Fruit Jars | 5 81 |
| " | 10. | Bausch & Lomb, Chemicals | 1 69 |
| " | 23 | Enz & Miller, Paper | 6 13 |
| " | 23. | Bausch & Lomb, Botanical Supplies | 25 50 |
| " | 23. | White & Burdick, Chemicals | 7 90 |
| " | 23. | E. McGillivray, Photographic Supplies | 32 32 |
| " | 23. | Rochester Optical Co., Photographic Supplies | 10 20 |
| " | 23. | J. B. McAllister, Meat for Experiment Purposes | 6 05 |
| 1897. | | | |
| Jan. | 12. | J. Carbutt, Photographic Supplies | 7 23 |
| " | 12. | Bausch & Lomb, Mirror | 40 |
| " | 12. | Bausch & Lomb, Filter | 3 00 |
| Feb. | 12. | U. S. Express Co., Expressage | 70 |
| " | 20. | E. Steigert & Co., Publications | 6 37 |
| " | 20. | G. E. Stechert, Publications | 92 |
| " | 20. | G. F. Atkinson, Traveling Expenses | 17 75 |
| " | 25. | G. E. Stechert, Publications | 10 60 |
| " | 25. | E. A. Allen, Publications | 20 09 |
| " | 27. | B. Fink, Lichens | 1 16 |
| Mar. | 6. | Bool Co., Furniture | 15 50 |
| " | 17. | White & Burdick, Chemicals | 7 84 |
| " | 29. | Bausch & Lomb, Microscopic Supplies | 1 53 |
| Apr. | 20. | U. S. Express Co., Expressage | 25 |
| " | 27. | Eimer & Amend, Microscope and Fixtures | 109 52 |
| May | 7. | B. Stoneman, Labor | 9 00 |
| June | 4. | B. Stoneman, Labor | 4 75 |
| " | 15. | White & Burdick, Chemicals | 8 09 |
| " | 15. | J. M. Thorburn & Co., Seeds | 2 85 |
| " | 15. | Cambridge Supply Co., Publications | 6 00 |
| " | 19. | G. E. Stechert. Publications | 3 54 |
| " | 19. | B. F. White, Photographic Supplies | 50 75 |
| " | 19. | Bool Co., Furniture | 75 48 |
| | | Total for Botanical Division | $664 11 |

FOR ENTOMOLOGICAL DIVISION.

| | | | |
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| 1896. | | | |
| July | 6. | Wm. Menzel & Co., Chemicals | 2 91 |
| " | 11. | M. V. Slingerland, Traveling Expenses | 3 30 |
| | | Amount carried forward | $6 21 |

| | | | |
|---|---|---|---|
| | | Amount brought forward . . . . . . . . . . | $6 21 |
| July | 13. | E. McGillivray, Photographic Supplies . . . . . . . | 6 79 |
| " | 13. | A. B. Kennedy, Supplies . . . . . . . . . . . . . . | 1 25 |
| " | 13. | J. B. Todd, Chemicals . . . . . . . . . . . . . . . | 1 63 |
| " | 24. | Treman, King & Co., Lime . . . . . . . . . . . . . | 95 |
| " | 24. | Andrus & Church, Stationery . . . . . . . . . . . | 50 |
| " | 29. | Treman, King & Co , Supplies . . . . . . . . . . . | 4 93 |
| " | 29. | Jamieson & McKinney, Rubber Hose and Fixtures . . | 4 20 |
| " | 29. | Treman, King & Co., Supplies . . . . . . . . . . . | 1 55 |
| " | 29. | A. B. Brooks, Chemicals . . . . . . . . . . . . . | 6 98 |
| " | 31. | P. Henderson, Seeds . . . . . . . . . . . . . . . | 77 |
| " | 31. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 24 00 |
| Aug. | 4. | Western Union Telegraph Co., Telegrams . . . . . . | 6 42 |
| " | 20. | Andrus & Church, Stationery . . . . . . . . . . . | 1 20 |
| " | 20. | Bool Co., Curtains . . . . . . . . . . . . . . . . | 1 20 |
| " | 20 | E. McGillivray, Photographic Supplies . . . . . . . | 2 52 |
| " | 31. | White & Burdick, Chemicals . . . . . . . . . . . . | 64 |
| " | 31. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 24 00 |
| Sept. | 8. | Andrus & Church, Stationery . . . . . . . . . . . | 6 00 |
| " | 8. | Treman, King & Co., Ash Can . . . . . . . . . . . | 2 15 |
| " | 9. | M. V. Slingerland, Express . . . . . . . . . . . . | 30 |
| " | 14. | Bausch & Lomb, Repairs . . . . . . . . . . . . . . | 29 |
| " | 28. | National Express Co., Expressage . . . . . . . . . | 25 |
| Oct. | 1. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 20 85 |
| " | 3. | U. S. Express Co., Expressage . . . . . . . . . . . | 50 |
| " | 6. | G. Cramer, Photographic Supplies . . . . . . . . . | 8 68 |
| " | 8. | U. S. Express Co., Expressage . . . . . . . . . . . | 2 15 |
| " | 12. | E. McGillivray, Photographic Supplies . . . . . . . | 2 70 |
| " | 17. | National Express Co., Expressage . . . . . . . . . | 25 |
| " | 29. | Bausch & Lomb, Photographic Supplies . . . . . . . | 56 |
| " | 31. | National Express Co., Express . . . . . . . . . . | 25 |
| " | 31. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 10 00 |
| Nov. | 18. | Rothschild Bros., Lamp . . . . . . . . . . . . . . | 1 97 |
| " | 18. | Peter Henderson, Plants . . . . . . . . . . . . . . | 4 70 |
| " | 21. | U. S. Express Co., Expressage . . . . . . . . . . . | 90 |
| Dec. | 1. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 11 40 |
| " | 7. | D. B. Stewart & Co., Oil . . . . . . . . . . . . . | 4 32 |
| " | 9. | Taylor & Preswick, Stationery . . . . . . . . . . . | 1 00 |
| " | 10. | C. U. Dept. of Repairs . . . . . . . . . . . . . . | 89 |
| " | 23. | Treman, King & Co., Supplies . . . . . . . . . . . | 2 23 |
| " | 23. | C. U. Dept. of Repairs, Repairs . . . . . . . . . . | 5 33 |
| " | 23. | E McGillivray, Photographic Supplies . . . . . . . | 3 45 |
| " | 31. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 14 25 |
| 1897. | | | |
| Jan. | 6 | Andrus & Church, Stationery . . . . . . . . . . . | 1 55 |
| " | 6. | E. McGillivray, Photographic Supplies . . . . . . . | 1 75 |
| " | 12. | Andrus & Church, Stationery . . . . . . . . . . . | 50 |
| " | 13. | M. V. Slingerland, Labor . . . . . . . . . . . . . | 2 70 |
| " | 26. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 14 55 |
| Feb. | 11. | L. Lauren, Labor . . . . . . . . . . . . . . . . . | 11 25 |
| " | 25. | M. V. Slingerland, Express . . . . . . . . . . . . | 1 50 |
| " | 25. | Taylor & Preswick, Typewriter Ribbon . . . . . . . | 75 |
| " | 27. | W. A. Slingerland, Labor . . . . . . . . . . . . . | 16 50 |
| Mar. | 6. | Andrus & Church, Stationery . . . . . . . . . . . | 90 |
| | | Amount carried forward . . . . . . . . . . . | $253 06 |

| | | | |
|---|---|---|---|
| | | Amount brought forward | $253 06 |
| Mar. | 23. | L. V. R. R. Co., Freight and Cartage | 85 |
| " | 29. | A. B. Little, Typewriter Ribbon | 1 50 |
| " | 31. | W. A. Slingerland, Labor | 14 25 |
| pr. | 10. | U. S. Express Co., Expressage | 1 25 |
| " | 28. | L. V. R. R. Co., Freight and Cartage | 50 |
| May | 1. | W. A. Slingerland, Labor | 15 70 |
| " | 1. | W. F. Falconer Mfg. Co., Supplies | 15 00 |
| " | 1. | Andrus & Church, Supplies | 7 60 |
| " | 15. | Mary Rogers, Labor | 63 00 |
| " | 18. | U. S. Express Co., Expressage | 80 |
| " | 22. | Andrus & Church, Stationery | 75 |
| June | 1. | W. A. Slingerland, Labor | 14 55 |
| " | 2. | Library Bureau, Supplies | 2 50 |
| " | 3. | Andrus & Church, Stationery | 2 40 |
| " | 3. | Treman, King & Co., Torch | 45 |
| " | 7. | Library Bureau, Supplies | 2 80 |
| " | 7. | Hawkins & Todd, Pins | 2 50 |
| " | 7. | White & Burdick, Chemicals | 3 26 |
| " | 7. | Bausch & Lomb, Supplies | 9 49 |
| " | 9. | Andrus & Church, Stationery | 3 00 |
| " | 12. | Lucy Torrance, Labor | 2 20 |
| " | 25. | C. U. Dept. of Repairs, Repairs | 23 70 |
| " | 24. | Whitehall, Tatum & Co., Chemicals | 9 45 |
| | | Total for Entomological Division | $450 56 |

FOR DAIRY BACTERIOLOGICAL DIVISION.

| | | | |
|---|---|---|---|
| 1897. | | | |
| June | 2. | William Boekel & Co., Incubator | 95 00 |
| " | 5. | L. V. R. R. Co., Freight and Cartage | 1 73 |
| " | 30. | Edward Pennock, Microscope and Fixtures | 298 88 |
| | | Total for Bacteriological Division | $395 61 |

FOR VETERINARY SCIENCE DIVISION.

| | | | |
|---|---|---|---|
| 1897. | | | |
| May | 6. | C. E. Bruce, Cow for Experimental Purposes | 30 00 |
| " | 12. | J. C. Hart, Cow for Experimental Purposes | 55 00 |
| | | | $85 00 |

# SUMMARY.

*The Agricultural Experiment Station of Cornell University, in account with the United States appropriation.*

| | | | |
|---|---|---|---|
| 1897. | Dr. | | |
| | To Receipts from Treasurer of the United States as per appropriation for the year ending June 30, 1897, under Act of Congress approved March 2, 1887 . . . | | $13,500 00 |
| | Cr. | | |
| June 30. | By Salaries . . . . . . . . . . . . . . . . . . | $8,043 75 | |
| | Printing . . . . . . . . . . . . . . . . . . | 351 75 | |
| | Office Expenses . . . . . . . . . . . . . | 1,029 09 | |
| | EQUIPMENT, LABOR AND CURRENT EXPENSES. | | |
| | Agriculture . . . . . . . . . . . . . . . | 694 02 | |
| | Horticulture . . . . . . . . . . . . . . . . | 1,343 15 | |
| | Chemistry . . . . . . . . . . . . . . . . . | 442 96 | |
| | Botany . . . . . . . . . . . . . . . . . . | 664 11 | |
| | Entomology . . . . . . . . . . . . . . . | 450 56 | |
| | Dairy Bacteriology . . . . . . . . . . . | 395 61 | |
| | Veterinary Science . . . . . . . . . . . | 85 00 | |
| | | | $13,500 00 |
| | RECEIPTS FOR PRODUCE SOLD. | | |
| | Balance from 1895–6 . . . . . . . . . . . | 850 29 | |
| | Agricultural Division . . . . . . . . . | 34 00 | |
| | Horticultural Division . . . . . . . . . | 89 54 | |
| | Office . . . . . . . . . . . . . . . . . . | 35 75 | |
| | | | $ 1,009 58 |
| | Printing. . . . . . . . . . . . . . . . . . | 427 34 | |
| | Office . . . . . . . . . . . . . . . . . . . | 16 | |
| | Balance to 1897–8 . . . . . . . . . . . . | 582 08 | |
| | | | $ 1,009 58 |

# GENERAL INDEX.

# INDEX OF CUTS.

# APPENDIX III.

# Teacher's Leaflets on Nature-Study.

No. 1. How a Squash Plant gets out of the Seed.

No. 2. How a Candle Burns.

No. 3. Four Apple Twigs.

No. 4. A Children's Garden.

No. 5. Some Tent Makers.

No. 6. What is Nature-Study?

No. 7. Hints on Making Collections of Insects.

THIRD EDITION.

No. 1.

DEC. 1, 1896.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

PREPARED BY

THE COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY,
ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

# How a Squash Plant Gets Out of the Seed.

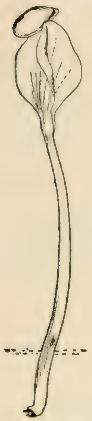
BY L. H. BAILEY.

1. *Squash plant a week old.*

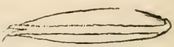
If one were to plant seeds of a Hubbard or Boston Marrow squash in loose, warm earth in a pan or box, and were then to leave the parcel for a week or ten days, he would find, upon his return, a colony of plants like that shown in Fig. 1. If he had not planted the seeds himself or had not seen such plants before, he would not believe that these curious plants would ever grow into squash vines, so different are they from the vines which we know in the garden. This, itself, is a most curious fact,—this wonderful difference between the first and the later stages of all plants, and it is only because we know it so well that we do not wonder at it.

NOTE.—These leaflets are intended for the teacher, not for the scholars. It is their purpose to suggest the method which a teacher may pursue in instructing children at odd times in nature-study. The teacher should show the children the objects themselves,--should plant the seeds, raise the plants, collect the insects, etc. ; or, better, he should interest the children to collect the objects. Advanced pupils, however, may be given the leaflets and asked to perform the experiments or make the observations which are suggested. The scholars themselves should be taught to do the work and to arrive at independent conclusions. Teachers who desire to inform themselves more fully upon the motives of this nature-study teaching, should write for a copy of Bulletin 122, of the Cornell Experiment Station, Ithaca, N. Y.

It may happen, however,—as it did in a pan of seed which I sowed a few days ago—that one or two of the plants may look like that shown in Fig. 2. Here the seed seems to have come up on top of the plant, and one is reminded of the curious way in which beans come up on the stalk of the young plant. If we were to study the matter, however,—as we may do at a future time—we should find a great difference in the ways in which the squashes and the beans raise their seeds out of the ground. It is not our purpose to compare the squash and the bean at this time, but we are curious to know why one of these squash plants brings its seed up out of the ground whilst all the others do not. In order to find out why it is, we must ask the plant, and this asking is what we call an experiment.

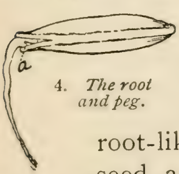


2. *Squash plant which has brought the seed-coats out of the ground.*

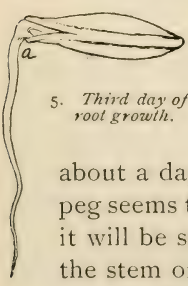


3. *Germination just beginning.*

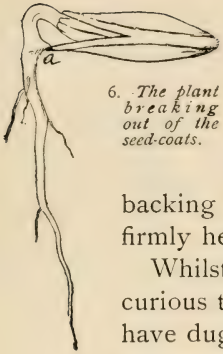
We may first pull up the two plants. The first one (Fig. 1) will be seen to have the seed-coats still attached to the very lowest part of the stalk below the soil, but the other plant has no seed at that point. We will now plant more seeds, a dozen or more of them, so that we shall have enough to examine two or three times a day for several days. A day or two after the seeds are planted, we shall find a little point or root-like portion breaking out of the sharp end of the seed, as shown in Fig. 3. A day later this root portion has grown to be as long as the seed itself (Fig. 4), and it has turned directly downwards into the soil. But there is another most curious thing about this germinating seed. Just where the root is breaking out of the seed (shown at *a* in Fig. 4), there is a little peg or projection. In Fig. 5, about a day later, the root has grown still longer, and this peg seems to be forcing the seed apart. In Fig. 6, however, it will be seen that the seed is really being forced apart by the stem or the stalk above the peg, for this stem is now growing longer. The lower lobe of the seed has attached




4. *The root and peg.*




5. *Third day of root growth.*

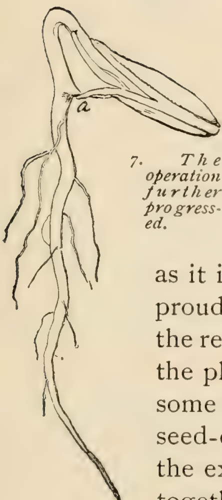


6. *The plant breaking out of the seed-coats.*

to the peg (seen at *a*, Fig. 6), and the seed-leaves are trying to back out of the seed. Fig. 7 shows the seed still a day later. The root has now produced many branches and has thoroughly established itself in the soil. The top is also growing rapidly and is still backing out of the seed, and the seed-coats are still firmly held by the obstinate peg.

8. *The plant just coming up.*

Whilst we have been seeing all these curious things in the seeds which we have dug up, the plantlets which we have not disturbed have been coming through the soil.



7. *The operation further progressed.*

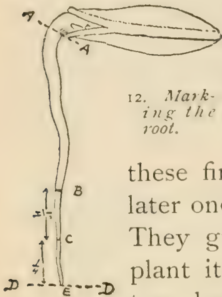
If we were to see the plant in Fig. 7, as it was "coming up," it would look like Fig. 8. It is tugging away trying to get its head out of the bonnet which is pegged down underneath the soil, and it has "got its back up" in the operation. In Fig. 9, it has escaped from its trap and it is laughing and growing in delight. It must now straighten itself up, as it is doing in Fig. 10, and it is soon standing proud and straight, as in Fig. 1. We now see that the reason why the seed came up on the plant in Fig. 2, is because in some way the peg did not hold the seed-coats down (see Fig. 13), and the expanding leaves are pinched together, and they must get themselves loose as best they can.

9. *The plant liberated from the seed-coats.*

There is another thing about this curious squash plant which we must not fail to notice, and this is the fact that these first two leaves of the plantlet came out of the seed and did not grow out of the plant itself. We must notice, too, that these leaves are much smaller when they are first drawn out of the seed than they are when the plantlet has straightened itself up. That is, these leaves increase very much in size after they reach the light

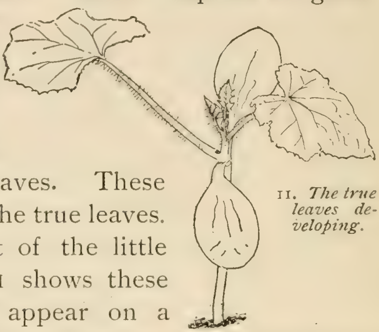
10. *The plant straightening up.*

and air. The roots of the plantlet are now established in the soil and are taking in food which enables the plant to grow.



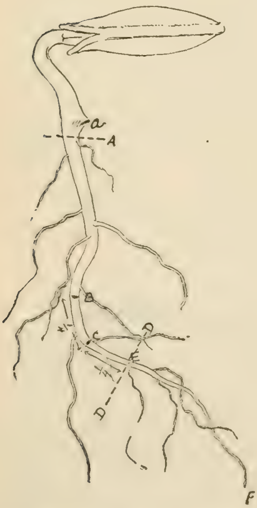

12. *Marking the root.*

The next leaves which appear will be very different from these first or seed leaves. These later ones are called the true leaves. They grow right out of the little plant itself. Fig. 11 shows these true leaves as they appear on a young Crookneck squash plant, and the plant now begins to look much like a squash vine.

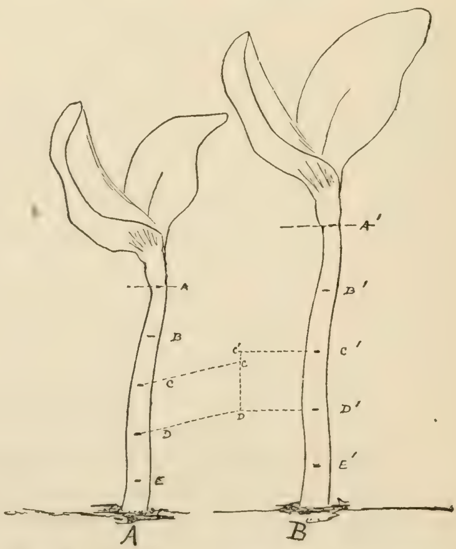


11. *The true leaves developing.*

We are now curious to know how the stem grows when it




13. *The root grows in the end portions.*




14. *The marking of the stem, and the spreading apart of the marks.*

backs out of the seeds and pulls the little seed leaves with it, and how the root grows downwards into the soil. Now let us pull up another seed when it has sent a single root about two

inches deep into the earth. We will wash it very carefully and lay it upon a piece of paper. Then we will lay a ruler alongside of it, and make an ink mark one-quarter of an inch from the tip, and two or three other marks at equal distances above (Fig. 12).* We will now carefully replant the seed. Two days later we will dig it up, when we shall most likely find a condition something like that in Fig. 13. It will be seen that the marks E, C, B, are practically the same distance apart as before and they are also the same distance from the peg AA. The point of the root is no longer at DD, however, but has grown on to F. The root, therefore, has grown almost wholly in the end portion.

Now let us make a similar experiment with the stem or stalk. We will mark a young stem, as at A in Fig. 14; but the next day we shall find that these marks are farther apart than when we made them (B, Fig. 14). The marks have all raised themselves above the ground as the plant has grown. The stem, therefore, has grown between the joints rather than from the tip. The stem usually grows most rapidly, at any given time, at the upper or younger portion of the joint (or internode); and the joint soon reaches the limit of its growth and becomes stationary, and a new one grows out above it.

*Natural science consists in two things,—seeing what you look at, and drawing proper conclusions from what you see.*

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* NOTE.—Common ink will not answer for this purpose because it "runs" when the root is wet, but indelible ink, used for marking linen or for drawing, should be used. It should also be said that the root of the common pumpkin, and of the summer bush squashes, is too fibrous and branchy for this test. It should be stated, also, that the root does not grow at its very tip, but chiefly in a narrow zone just back of the tip; but the determination of this point is rather too difficult for the beginner, and, moreover, it is foreign to the purpose of this tract.

To the Teacher:

*This is the first of a proposed series of leaflets designed to suggest methods of presenting nature-study upon common-place subjects. This is a new field of effort for the College of Agriculture, and we therefore look upon the methods as largely experimental. We are endeavoring to determine the best way of interesting children in country life. You can give us many suggestions, and we should like a free expression of your opinions and experiences. It should be borne in mind that the object of these lessons is not to impart direct and specific information, but to train the child in the powers of seeing and inquiring. The teacher should keep the attention of the pupil closely fixed upon the germinating seed (when the subject of this leaflet is under review), asking him to describe everything which he sees. Require that the pupil sees all that is specified in this leaflet, and endeavor to lead him on to see things which are not here described. Once the inquiry is started, you will no doubt be able to conduct other similar experiments from time to time. If questions come up which you cannot answer, write them to us and we may be able to help you.*

*We suggest that you ask your pupils to write short compositions upon these lessons and to make sketches of the observations, and that you send us some of these from time to time, in order that we may learn how the experiment is working. We do not care for the best essays alone, but simply the average. The suggestions which we obtain from teachers will aid us greatly in the preparation of future leaflets.*

THIRD EDITION.

# TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

No. 2.

MAY 21, 1897.

PREPARED BY

THE COLLEGE OF AGRICULTURE,
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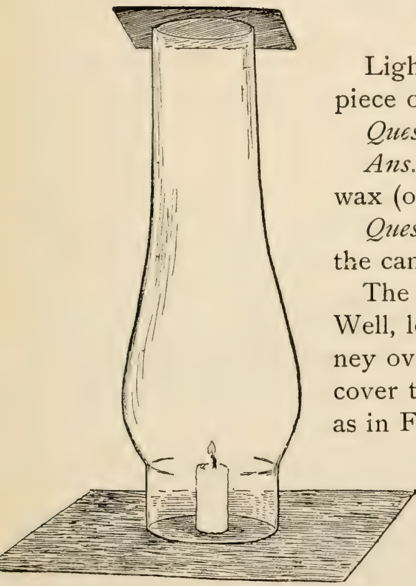
Issued under Chapter 128
of the Laws of 1897.

# How a Candle Burns.

BY GEORGE W. CAVANAUGH.



15. *The beginning of the experiment.*

## I. Oxygen.

Light the candle and place it upon a piece of blotting paper.

*Ques.* What do you see burning?

*Ans.* The candle; or the wick and wax (or tallow).

*Ques.* Is anything burning besides the candle?

The answer will probably be "No." Well, let us see. Place the lamp chimney over the lighted candle, and partly cover the top by a piece of stiff paper, as in Fig. 15. Ask the pupils to observe and describe how the flame goes out; i. e., that it is gradually extinguished and does not go out instantly.

*Ques.* Why did the flame go out?

The probable answer will be, "Because there was no air." (If there was no air within the chimney, some could have entered

NOTE TO THE TEACHER.—The materials needed for this exercise are a piece of candle about two inches long, a lamp chimney (one with a plain top is best), a

at the top.) Place a couple of pencils beside the relighted candle and on them the chimney, as in Fig. 16.

*Ques.* What is the difference between the way in which the candle burns now and before the chimney was placed over it?

*Ans.* It flickers, or dances about more.

*Ques.* What makes boys and girls feel like dancing about when they go out from a warm school room?

*Ans.* The fresh air.

*Ques.* What makes the flame dance or flicker when the chimney is raised by the pencils?

*Ans.* Because it gets fresh air under the chimney.

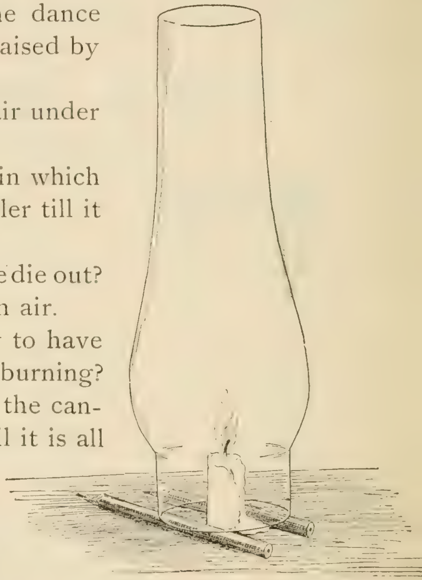
Repeat the first experiment, in which the flame grows gradually smaller till it is extinguished.

*Ques.* Why now does the flame die out?

*Ans.* Because it had no fresh air.

*Ques.* Is it really necessary to have fresh air in order to keep a flame burning?

*Ans.* Yes; since otherwise the candle would continue to burn until it is all used up.



16. *Supplying air underneath the chimney.*

To prove this further, let the candle be relighted. Place the chimney over it, now having the top completely closed by a piece of paper. Have ready a lighted splinter or match, and

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piece of white crockery or window glass, a piece of fine wire about six inches long, a bit of quicklime about half the size of an egg, and some matches. All of these, with the possible exception of the quicklime, can be obtained in any household. If you perform the experiment requiring the lime, be sure that you start with a fresh piece of quick or stone lime, which can be had of any lime or cement dealer. During the performance of the following simple experiments, ask your pupils to describe to you what they see you do at each step. The questions inserted in the text are offered merely as suggestions in the developing of the desired ideas. The answers, which are intended only for the teacher, are those which it is desired shall be given by the pupils.

just as soon as the candle is extinguished remove the paper from the chimney-top and thrust in the lighted splinter.

*Ques.* Why does the light on the splinter go out?

*Ans.* Because there is no fresh air inside the chimney.

*Ques.* What became of the freshness that was in the air?

*Ans.* It was destroyed by the burning candle.

Evidently there is some decided difference between fresh air and air from which the freshness has been burned, since a flame can continue to burn only in air that has the quality known as freshness. This quality in fresh air is due to a gas which has the name of oxygen, and which is represented by the letter O.

*Ques.* Why was the splinter put out instantly while the candle flame died out gradually?

*Ans.* When the splinter was thrust in, the air had no freshness or oxygen at all, while when the candle was placed under the chimney it had whatever oxygen was originally in the air within the chimney.

Endeavor to have this point clearly understood: that the candle did not go out as long as the air had any oxygen and that the splinter was extinguished immediately because there was no oxygen left. Relight the candle. Our second question may now be repeated:

*Ques.* Is anything else burning besides the candle?

*Ans.* Yes; the oxygen of the air.

When the subject of the necessity of fresh air and consequently of oxygen for the burning of the candle seems to be understood, the following questions, together with any others which suggest themselves, may be asked.

What is the reason that draughts are opened in stoves?

Why is the bottom of a "burner" on a lamp always full of holes?

## II. Carbon.

Let us now observe the blackened end of a burned match or splinter. This black substance is usually known by the name of charcoal and if handled will blacken the fingers. Try this. The same substance is found on the bottoms of kettles which have been used over a wood fire, only it is a fine powder.

Let us see what was burning when the candle was lighted, besides the oxygen in the air. Relight the candle and hold the porcelain or glass about an inch above the bright part of the flame.

*Ques.* What happens to it there ?

Next lower it directly into the flame. (Fig. 17.)

*Ques.* What is the black stuff that gets onto the glass ?

Look closely and see whether it is not deposited here also as a fine powder.

*Ques.* Will this deposit from the candle blacken the fingers ?

17. *The carbon or soot on the glass.*

Instead of using the name charcoal for this black substance, let us call it carbon (represented by C), the better name, because there are several kinds of carbon, and charcoal is only that kind which is rather light and easily blackens the hands. Some other kinds are the diamond, coal and the black substance in lead pencils. This last kind is called graphite. These are all much harder than charcoal.

The carbon from the candle flame came mostly from the wax or tallow ; only a very small portion came from the wick.

It cannot be seen in the tallow, neither can it be seen in unburned wood, and yet it can be found when the wood is partly burned. The condition in which the carbon exists in the tallow or wood may be explained in a later lesson. At present it suffices that it is there.

Why, now, is the glass blackened when held in the flame and not when held just directly above it ? It is because the carbon from the candle has not been completely burned at the middle of the flame ; but it is burned beyond the bright part of the flame. When the glass is held in the flame, the carbon that is not yet completely burned is deposited on it, because it is cooler than that in the surrounding flame.

A fine deposit of carbon can be had from any of the luminous parts of the flame ; and it is these thousands of little particles of carbon, getting white hot, which glow like coals in the stove and

make the light. Just as soon as they are completely burned, there is no more light, the same as coals cease to glow when burned to ashes.

### III. Carbon dioxid.

Let us now enquire what becomes of the carbon that we find in the bright part of the flame and of the oxygen that was in the air in the lamp chimney. When the candle was extinguished within the chimney there was no oxygen left, as shown by the lighted splinter which was put out immediately. Neither could any of the particles of carbon be found except on the wick. Yet they both still exist within the chimney but in an entirely different condition than before. While the candle was burning the little particles of carbon that we find ascending in the flame are joining with the oxygen of the air and making an entirely new substance. This new substance is a gas like oxygen and can not be seen in the air.

*Ques.* Of what two substances is this new substance made?

*Ans.* Carbon and Oxygen.

What shall we call this substance? Since it is made of carbon and oxygen it ought, if possible, to have a name that will show its composition. Its name is carbon dioxid. The words carbon and oxid show of what it is made and the prefix *di*, which means two, shows that it contains twice as much oxygen as carbon. This is represented by the formula $CO_2$.

Place the bit of quicklime in about half a glass of water on the day previous to the experiment. When ready for use there will be a white sediment at the bottom and a thin white scum on the top of the clear lime water. Call the attention of the pupils to this white scum as a question about it will follow. Make a loop in the end of the piece of wire by turning it around the point of a lead pencil. Remove the scum from the lime water with a piece of paper and insert the loop into the clear water. When withdrawn, the loop ought to hold a film of clear water. Pass the wire through a piece of cardboard or stiff paper, and arrange as shown in Fig. 18.

Place the chimney over the lighted candle. Lower the loop into the chimney and cover the top of the chimney with the

paper. Withdraw the wire a couple of minutes after the candle goes out. Note the cloudy appearance of the film of water on the wire. The cloudiness was caused by the carbon dioxid formed while the candle was burning.

Omitting the candle, hang the freshly wetted wire in the empty chimney. Let the film of lime water remain within the chimney for the same length of time as when the candle was used. It does not become cloudy now. The cloudiness in clear lime water is a test or indication that carbon dioxid is present.

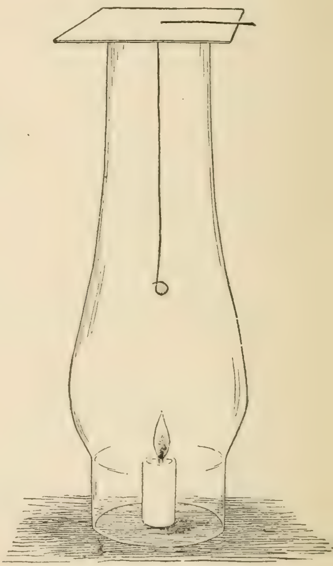
*Ques.* What caused the white scum on the lime water which stood over night?

*Ans.* Some $CO_2$ in the air.

*Ques.* How does the $CO_2$ get into the air?

*Ans.* It is formed whenever wood, coal, oil or gas is burned.

The amount of $CO_2$ in ordinary air is very small, being only three parts in ten thousand. If the lime water in the loop be left long enough in the air it will become cloudy. The reason it clouds so quickly when the candle is being burned is that a large amount of $CO_2$ is formed. Besides being made by real flames, $CO_2$ is formed every time we breathe out air. Renew the film of water in the loop and breathe against it gently for two or three minutes.



18. *The test with the film of lime water.*

The presence of $CO_2$ in the breath may be shown better by pouring off some of the clear lime water into a clean glass and blowing into it through a straw.

An interesting question to end the lesson with is: Why does water put out a fire? The answer is, not alone because it wets, but because it cools the carbon, which must be hot in order to unite with the oxygen, and prevents the oxygen of the air from getting as near the carbon as before.

To the Teacher:

*This is the second of a proposed series of leaflets designed to suggest methods of presenting nature study upon common-place subjects. This is a new field of effort for the College of Agriculture, and we therefore look upon the methods as largely experimental. We are endeavoring to determine the best way of interesting children in country life. You can give us many suggestions, and we should like a free expression of your opinions and experiences. It should be borne in mind that the object of these lessons is not to impart direct and specific information, but to train the child in the powers of seeing and inquiring. The teacher should keep the attention of the pupil closely fixed upon the experiments, asking him to describe everything which he sees. Require that the pupil sees all that is specified in this leaflet, and endeavor to lead him on to see things which are not here described. Once the inquiry is started, you will no doubt be able to conduct other similar experiments from time to time. If questions come up which you cannot answer, write them to us and we may be able to help you.*

*We suggest that you ask your pupils to write short compositions upon these lessons and to make sketches of the observations, and that you send us some of these from time to time in order that we may learn how the experiment is working. We do not care for the best essays alone, but simply the average. The suggestions which we obtain from teachers will aid us greatly in the preparation of future leaflets. We should particularly appreciate suggestions as to the most useful subjects to be taken up in these tracts.*

# Teacher's Leaflets on Nature-Study.

## NO. 3.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

FOURTH ISSUE.

No. 3.

JUNE 1, 1897.

PREPARED BY

THE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,

ITHACA, N. Y.

Issued under Chapter 128 of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

# Four Apple Twigs.

BY L. H. BAILEY.

The other day, as I walked through an apple orchard for the first time since the long winter had set in, I was struck by the many different shapes and sizes of the limbs as I saw them against the blue-gray of the February sky. I cut four of them in passing, and as I walked back to the house I wondered why the twigs were all so different; and I found myself guessing whether there would be any apples next summer.

Now, I have had pictures made of these four little apple limbs. Let us look them over and see if they have any story to tell of how they grew and what they have set out to do.

## I.

One of these twigs (Fig. 19) was taken from a strong young tree which, I remember, bore its first good crop of apples last year. This simple twig is plainly of two years' growth, for the "ring" between the old and new wood is seen at B. That is, the main stem from the base up to B grew in 1895, and the part from B to the tip grew in 1896. But the buds upon these two parts look very unlike. Let us see what these differences mean.

We must now picture to ourselves how this shoot from B to 10 looked last summer whilst it was growing. The shoot bore leaves. Where? There was one just below each bud; or, to be more exact, one bud developed just above each leaf. These

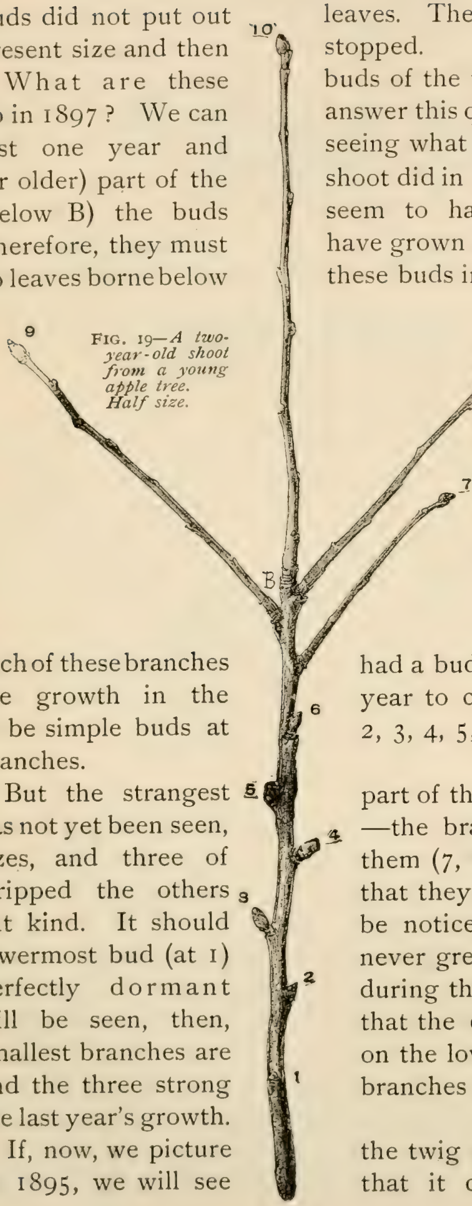


FIG. 19—*A two-year-old shoot from a young apple tree. Half size.*

buds did not put out leaves. They simply grew to their present size and then stopped.

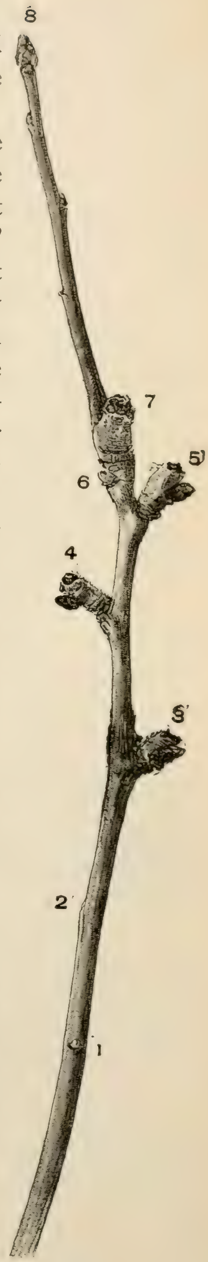
What are these buds of the tip shoot proposing to do in 1897? We can answer this question by going back just one year and seeing what the buds on the lower (or older) part of the shoot did in 1896. Upon that part (below B) the buds seem to have increased in size. Therefore, they must have grown last year. There were no leaves borne below these buds in 1896, but a cluster of leaves came out of each little bud in the spring. As these leaves expanded and grew, the little bud grew on; that is, each bud grew into a tiny branch, and when fall came each of these branches had a bud on its end to continue the growth in the year to come. What we took to be simple buds at 2, 3, 4, 5, 6 are, therefore, little branches.

But the strangest part of this wonderful little twig has not yet been seen,—the branches are of different sizes, and three of them (7, 8, 9) have so far outstripped the others that they seem to be of a different kind. It should be noticed, too, that the very lowermost bud (at 1) never grew at all, but remained perfectly dormant during the entire year 1896. It will be seen, then, that the dormant bud and the smallest branches are on the lower part of the shoot, and the three strong branches are at the very tip of the last year's growth.

If, now, we picture the twig as it looked in the fall of 1895, we will see that it consisted of a single

shoot, terminating at B. It had a large terminal bud (like those at 7, 8, 9, 10), and this bud pushed on into a branch in 1896, and three other buds near the tip did the same thing.

Why did some of these branches grow to be larger than others? "Simply because they were upon the strongest part of the shoot, or that part where the greatest growth naturally takes place," some one will answer. But this really does not answer the question, for we want to know why this portion of the shoot is strongest. The real reason is because there is more sunlight and more room on this outward or upward end. In 1897,—if this shoot had been spared—each of these four largest twigs (7, 8, 9, 10) would have done the same thing as the parent twig did in 1896: each would have pushed on from its end, and one or two or three other strong branches would probably have started from the wrong side buds near the tips, the very lowest buds would, no doubt, have remained perfectly inactive or dormant for lack of opportunity, and the intermediate buds would have made short branches like 2, 3, 4, 5, 6. In other words, the tree always tries to grow onward from its tips, and these tip shoots eventually become strong branches, unless some of them die in the struggle for existence. What, now, becomes of the little branches lower down?




## II.

From another apple tree I took the twig shown in Fig. 20. We see at once that it is very unlike the other one. It seems to be two years old, one year's growth extending from the base up to 7, and the last year's growth extending from 7 to 8; but we shall see upon looking closer that this is not so. The short branchlets at 3, 4, 5, 7 are very different from those in Fig. 19. They seem to be broken off. The fact is that

the broken ends shown where the apples were borne in 1896. The branchlets that bore them, therefore, must have grown in 1895, and the main branch, from 1 to 7, grew in 1894. It is plain, from the looks of the buds, that the shoot from 7 to 8, grew last year, 1896.

Starting from the base, then, we have the main twig growing in 1894; the small side branches growing in 1895; these little branches bearing apples in 1896, and the terminal shoot also growing in 1896. Why was there no terminal shoot growing in 1895? Simply because its tip developed a fruit-bud (at 7) and therefore could not send out a branch; for there are two kinds of buds,—the small pointed leaf-bud and the thick blunt fruit-bud. If the branchlets 3, 4, 5, 7, are two years old, the dormant buds—1, 2—must be the same age. That is, for two long years these little buds have been waiting for some bug to eat off the buds and leaves above, or some accident to break the shoot beyond them, so that they might have a chance to grow; but they have waited in vain.

We have now found, therefore, that the little side shoots upon apple twigs become fruit-branches or fruit-spurs, whilst the more ambitious branches above them are making a great display of stem and leaves.

But will these fruit-spurs bear fruit again in 1897? No. The bearing of an apple is hard work, and these spurs did not have enough vitality left to make fruit-buds for the next year; but they must perpetuate themselves, so they have sent out small side buds which will bear a cluster of leaves and grow into another little spur in 1897, and in that year these new spurs will make fruit-buds for bearing in 1898. The side bud is plainly seen on spur 5, also on spur 4, whilst spur 7 has sown a seed, so to speak, in the bud at 6. It is therefore plain why the tree bears every other year.

## III.

There was one tree in the orchard from which the farmer had not picked his apples. Perhaps the apples were not worth picking. At any rate, the dried apples, shriveled and brown, are

still hanging on the twigs, and even the birds do not seem to care for them. I broke off one of these twigs (Fig. 21). Let us see how many apples this curious twig has borne. We can tell by the square-cut scars. An apple was once borne at 1, another at 2, another at 4, another at 5, another at 6, and another at 7,—and at 7 there will be a scar when the apple falls. Six apples this modest shoot has borne! And I wonder how many of them got ripe, or how many were taken by the worms, or how many were eaten by the little boys and girls on their way to school!

A curious thing happened when the fruit was growing at 2. Two side buds started out, instead of one, and both of them grew the next year. But one of the little branchlets fell sick and died, or a bug nipped off its end, or it starved to death; and the grave is still marked by the little stick standing up at 3. The other branchlet thrived, and eventually bore apples at 4, 5, 6 and 7.

I have said that these fruit-spurs bear only every other year; then, if this branch has borne six apples, it must be twelve


FIG. 21.—*A fruit-spur which has borne six apples. Half size.*

years old. The truth is that it is about twenty years old, for some years it failed to bear; but the age cannot be traced out in the picture, although any little boy or girl with bright eyes could soon learn to trace out yearly rings on the shoot itself.

## IV.

The last shoot which I got that day has a whole volume of history in it, and I cannot begin to tell its story unless I should

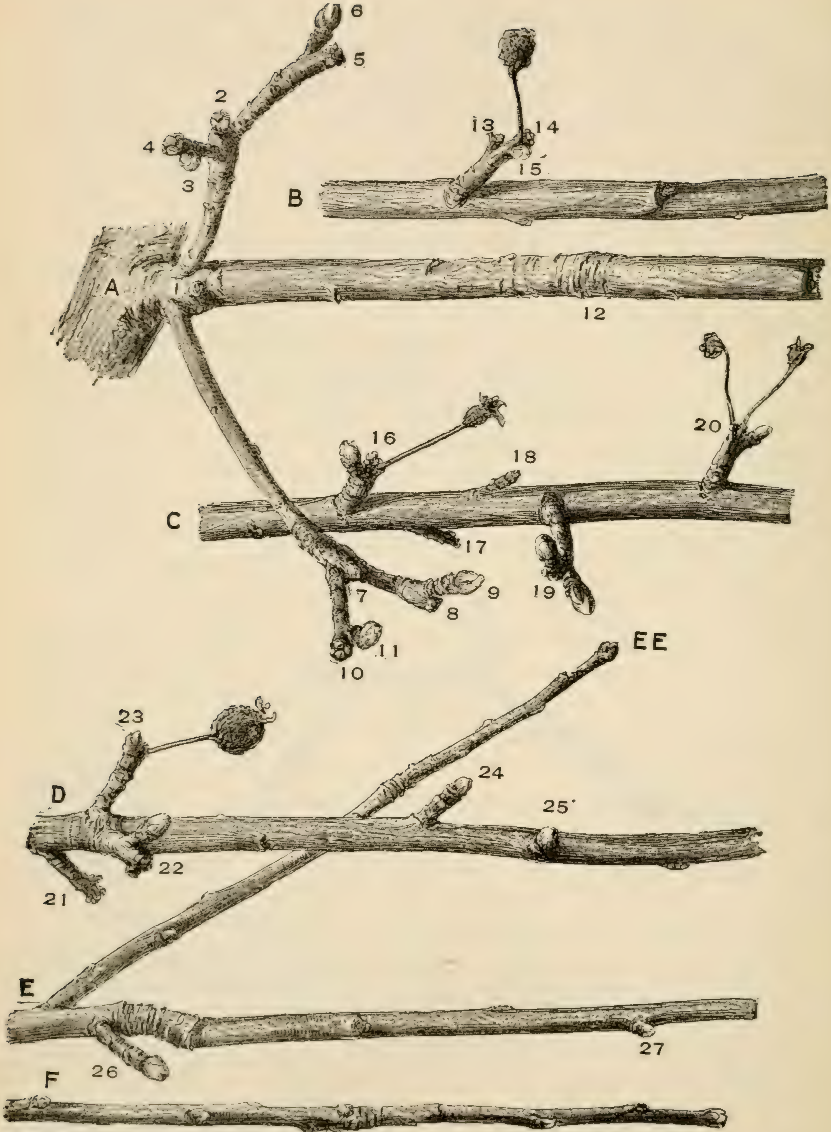



FIG. 22.—*A seven-year old apple twig and its curious history. Half size.*

write a small book. But we will trace out its birthdays and see how many apples it has borne. It is shown in Fig. 22, and because it is so long I have had to break it in two several times to get it on the page. It begins at A, and is continued at B, C, D, E, and F.

Let us count the yearly rings and see how old the whole limb is. These rings are at 28, 26, D, 12, 1,—five of them; and as the shoot grew one year before it made any ring, and another year made no increase in length—as we shall presently see—the whole branch must be seven years old. That is, the limb probably started in 1890.* Let us begin, then, at A, and follow it out.

1890. Started as a spur from the main branch, A, and grew to 1.

1891. Apple borne at 1. This apple did not mature, however, as we can readily see by the smallness of the scar. In this year, two side buds developed to continue the spur the next year.

1892. Gave up its desire to be a fruit-spur, and made a strong growth on to 12. For some reason, it had a good chance to grow. Perhaps the farmer pruned the tree, and thereby gave the shoot an opportunity; or perhaps he plowed and fertilized the land.

In the meantime one of the side buds grew to 3, and the other to 7, and each made a fruit-bud at its end.

1893. Shoot grew lustily,—on to D.

The fruit-bud at 3 bore an apple, which probably matured, as shown by the scar 2. Two side buds were formed beneath this apple to continue the spur next year.

The fruit-bud at 7 bloomed, but the apple fell early, as shown by the small scar. Two side buds were formed.

The buds upon the main shoot—1 to 12—all remained dormant.

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* It is really impossible to tell whether the shoot started from the limb A in 1889 or 1890, without knowing the age of A; for the spur may have developed its blossom bud at the end in either the first or second year of its life. That is, young fruit-spurs sometimes make a blossom bud the very year they start, but they oftener "stand still" the second year and delay the blossom bud until that time.

1894 Shoot grew from D to beyond E.

Side bud of 2 grew to 4, and made a fruit-bud on its end; the other side bud grew on to 5, and there made a fruit-bud.

Side bud of 7 grew on to 10, and the other one to 8, each ending in a fruit-bud.

Buds on old shoot—1 to 12—still remained dormant.

Some of the buds on the 1893 growth—12 to D—remained dormant, but some of them made fruit-spurs,—14, 16, 17, 18, 19, 20, 21, 22, 23.

1895. Shoot grew from beyond E to 28.

Flowers were borne at 4 and 5, but at 4 the fruit fell early, for the five or six scars of the flowers can be seen, showing that no one of them developed more strongly than the other; that is, none of the flowers "set." A fairly good fruit was probably borne at 5. At the base of each, a bud started to continue the spur next year.

Upon the other spur, flowers were borne both at 8 and 10. At 10 none of the flowers set fruit, but a side bud developed. At 8 the fruit partially matured, and a side bud was also developed.

The buds upon the old stem from 1 to 12 still remained dormant.

Some of the spurs on the 1893 growth—12 to D—developed fruit-buds for bearing in 1896.

Some of the buds on the 1894 growth—D to beyond E—remained dormant, but others developed into small fruit-spurs. One of these buds, near the top of the 1894 growth, threw out a long shoot, starting from E; and the bud at 26 also endeavored to make a long branch, but failed.

1896. Main shoot grew from 28 to the end.

The side bud below 4 (where the fruit was borne the year before), barely lived, not elongating, as seen above 3. This branch of the spur is becoming weak and will never bear again. The side bud of 5, however, made a fairly good spur and developed a fruit-bud at its end, as seen at 6.

The side bud of 10 grew somewhat, making the very short spur 11. This branchlet is also getting weak. The bud of 8, however, developed a strong spur at 9. Both 11 and 9 bear fruit-buds, but that on 11 is probably too weak ever to bear fruit again. In fact, the entire spurs, from 1 to 6 and 1 to 9, are too weak to be of much account for fruit-bearing.

This year several of the spurs along the 1893 growth—12 to D—bore flowers. Flowers were borne from two buds on the first one (at 13 and 14), but none of the flowers "set." One of the little apples that died last June still clings to the spur, at 14. A side bud, 15, formed to continue the spur in 1897. Flowers were borne at 16, 20, 21 and 23, but no apples developed. Upon 16 and 20 the flowers died soon after they opened, as seen by the remains of them. Upon 23 one of the flowers set an apple, but the apple soon died. The spurs 17 and 18 are so weak that they have never made fruit-buds, and they are now nearly dead. The spurs 19 and 22 have behaved differently. Like the others they grew in 1894 and would have made terminal fruit-buds in 1895, and would have borne fruit in 1896; but the terminal buds were broken off in the fall or winter of 1894, so that two side buds developed in 1895, and each of these developed a fruit-bud at its end in 1896 in the spur 19, but only one of them developed such a bud in 22. Upon these spurs, therefore, the bearing year has been changed.

Upon the growth of 1894—D to beyond E—only three spurs have developed, Nos. 24, 25, 26. These started out in 1895, and two of them—25 and 26—have made large, fat buds which are evidently fruit-buds. The shoot at E grew on to EE, and all the buds on its lower two-year old portion remained dormant.

On the 1895 growth—from beyond E to 28—all the buds remained dormant save one, and this one—27—made only a very feeble attempt to grow into a spur.

The buds upon the 1892 growth—1 to 12—are still dormant and waiting for an opportunity to grow.

What an eventful history this apple twig has had! And yet in all the seven years of its life, after having made fifteen efforts to bear fruit, it has not produced a single good apple! The fault, therefore, does not lie in the shoot. It has done the best it could. The trouble has been that the farmer either did not give the tree enough food to enable it to support the fruits, or he did not prune the tree so as to give the twig light and room, or he allowed apple-scab or some other disease to kill the young apples as they were forming. I am wondering, therefore, if, when the trees fail to bear, it is not quite as often the fault of the farmer as it is of the trees?

To the Teacher:

*This is the third of a proposed series of leaflets designed to suggest methods of presenting nature-study upon common-place subjects. This is a new field of effort for the College of Agriculture, and we therefore look upon the methods as largely experimental. We are endeavoring to determine the best way of interesting children in country life. You can give us many suggestions, and we should like a free expression of your opinions and experiences. It should be borne in mind that the object of these lessons is not to impart direct and specific information, but to train the child in the powers of seeing and inquiring. We suggest that you familiarize yourself thoroughly with the apple twigs in these four lessons, and then collect a few twigs and examine them for yourself. When you think that you understand such twigs, collect some more (or have the children collect them), and giving each pupil one, conduct an observation on them. If this work is done now whilst the twigs are dormant, you will find the children to be greatly interested in the trees when the buds begin to burst. Once the inquiry is started, you will no doubt be able to conduct other similar observations from time to time. If questions come up which you cannot answer, write them to us and we may be able to help you.*

*We suggest that you ask your pupils to write short compositions upon these lessons and to make sketches of what they see, and that you send us some of these from time to time in order that we may learn how the experiment is working. We do not care for the best essays alone, but simply the average. The suggestions which we obtain from teachers will aid us greatly in the preparation of future leaflets.*

FIFTH EDITION.

No. 4

JUNE 1, 1897.

# TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

PREPARED BY

## THE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY.

ITHACA, N. Y.

Issued under Chapter 128 of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

# A Children's Garden.

BY L. H. BAILEY.

We want every school child in the State to grow a few plants this summer. We want everyone of them to learn something of why and how plants grow, and the best and surest way to learn is to grow the plants and to watch them carefully. We want everyone to become interested in everything that lives and grows. It does not matter so very much just what kinds of plants one grows, as it does that he grows something and grows it the best that he knows how. We want the children to grow these plants for the love of it,—that is, for the fun of it—and so we propose that they grow flowers; for when one grows pumpkins and potatoes, and such things, he is usually thinking of how much money he is going to make at the end of the season. Yet, we should like some rivalry in the matter in every school, and we therefore propose that a kind of a fair be held at the school house next September, soon after school begins, so that each child may show the flowers which he has grown. What a jolly time that will be!

Now, we must not try to grow too many things or to do too much. Therefore, we propose that you grow sweet peas and China asters. They are both easy to grow, and the seeds are cheap. Each one has many colors, and everybody likes them. Now let us tell you just how we would grow them.

1. *The place.*—Never put them—or any other flowers—in the middle of the lawn,—that is, not out in the center of the

yard. They do not look well there, and the grass roots run under them and steal the food and moisture. I am sure that you would not like to see a picture hung up on a fence-post. It has no background, and it looks out of place. The picture does not mean anything when hung in such a spot. In the same way, a flower bed does not mean anything when set out in the center of a lawn. We must have a background for it, if possible,—a wall upon which to hang it. So we will put the flower bed just in front of some bushes or near the back fence, or alongside the smoke-house, or along the walk at the side of the house or in the back yard. The flowers will not only look better in such places, but it will not matter so much if we make a failure of our flower bed; there are always risks to run, for the old hen may scratch up the seeds, the cow may break into the yard some summer night, or some bug may eat the plants up.

Perhaps some of the children may live so near to the schoolhouse that they can grow their plants upon the school grounds, and so have sweet peas and asters where there are usually docks and smartweeds. Grow them alongside the fence, or against the schoolhouse if there is a place where the eaves will not drip on them.

2. *How to make the bed.*—Spade the ground up deep. Take out all the roots of docks and thistles and other weeds. Shake the dirt all out of the sods and throw the grass away. You may need a little manure in the soil, especially if the land is either very hard or very loose and sandy. But the manure must be very fine and well mixed into the soil. It is easy, however, to make sweet pea soil so rich that the plants will run to vine and not bloom well.

Make the bed long and narrow, but not narrower than three feet. If it is narrower than this, the grass roots will be apt to run under it and suck up the moisture. If the bed can be got at on both sides, it may be as wide as five feet.

Sow the seeds in little rows crosswise the bed. The plants can then be weeded and hoed easily from either side. If the rows are marked by little sticks, or if a strong mark is left in the earth, you can break the crust between the rows (with a

rake) before the plants are up. The rows ought to be four or five inches further apart than the width of a narrow rake.

3. *How to water the plants.*—I wonder if you have a watering-pot? If you have, put it where you cannot find it, for we are going to water this garden with a rake! We want you to learn, in this little garden, the first great lesson in farming,—how to save the water in the soil. If you learn that much this summer, you will know more than many old farmers do. You know that the soil is moist in the Spring when you plant the seeds. Where does this moisture go to? It dries up,—goes off into the air. If we could cover up the soil with something, we should prevent the moisture from drying up. Let us cover it with a layer of loose, dry earth! We will make this covering by raking the bed every few days,—once every week anyway, and oftener than that if the top of the soil becomes hard and crusty, as it does after a rain. Instead of pouring water on the bed, therefore, we will keep the moisture in the bed.

If, however, the soil becomes so dry in spite of you that the plants do not thrive, then water the bed. Do not *sprinkle* it, but *water* it. Wet it clear through at evening. Then in the morning, when the surface begins to get dry, begin the raking again to keep the water from getting away. Sprinkling the plants every day or two is one of the surest ways to spoil them.

4. *When and how to sow.*—The sweet peas should be put in just as soon as the ground can be dug, even before frosts are passed. Yet, good results can be had if the seeds are put in as late as the 10th of May. In the sweet pea garden at Cornell last year, we sowed the seeds on the 20th of April. This was about right. The year before, we sowed them on the 30th. If sown very early, they are likely to bloom better, but they may be gone before the middle of September. The blooming can be much prolonged if the flowers are cut as soon as they begin to fade.

Plant sweet peas deep,—two to three or sometimes even four inches. When the plants are a few inches high, pull out a part of them so that they will not stand nearer together than six inches in the row. It is a good plan to sow sweet peas in

double rows,—that is, put two rows only five or six inches apart —and stick the brush or place the chicken-wire support between them.

China asters may be sown from the middle of May to the first of June. In one large test at Cornell, we sowed them the 4th of June and had good success, but this is rather later than we would advise. The China asters are autumn flowers, and they should be in their prime in September and early October.

Sow the aster seed shallow,—not more than a half inch deep. The tall kinds of asters should have at least a foot between the plants in the row, and the dwarf kinds six to eight inches.

Sometimes China asters have rusty or yellow spots on the undersides of their leaves. This is a fungous disease. If it appears, have your father make some ammoniacal carbonate of copper solution and then spray them with it; or Bordeaux mixture will do just as well or better, only that it discolors the leaves and flowers.

5. *What varieties to choose.*—In the first place, do not plant too much. A garden which looks very small when the pussy-willows come out and the frogs begin to peep, is pretty big in the hot days of July. A garden four feet wide and twenty feet long, half sweet peas and half asters, is about as big as most boys and girls will take care of.

In the next place, do not get too many varieties. Four or five kinds each of peas and asters will be enough. Buy the named varieties,—that is, those of known colors—not the mixed packets. If you are very fond of reds, then choose the reddest kinds; but it is well to put in at least three colors. The varieties which please you may not please me or your neighbor, so that I cannot advise you what to get, but I will give some lists which may help you.

Amongst all the sweet peas grown at Cornell last year, the following seemed to be best on our grounds:

| | |
|---|---|
| Dark purple. | *Waverly.* |
| | *Duke of Clarence.* |
| triped purple. | *Gray Friar.* |
| | *Juanita.* |
| | *Senator.* |

| | |
|---|---|
| Lavender. | *Countess of Radnor.* |
| | *Dorothy Tennant.* |
| | *Lottie Eckford.* |
| White. | *The Bride.* |
| | *Emily Henderson.* |
| | *Queen of England, Alba Magnifica.* |
| Primrose. | *Mrs. Eckford.* |
| White flushed with pink. | *Blushing Beauty.* |
| | *Katherine Tracy.* |
| | *Eliza Eckford.* |
| Striped or flaked pink. | *Ramona.* |
| | *Mrs. Joseph Chamberlain.* |
| Orange-pink. | *Lady Penzance.* |
| | *Meteor.* |
| Rose-pink. | *Her Majesty.* |
| | *Splendor.* |
| | *Apple Blossom.* |
| | *Boreatton.* |
| Rose-pink shaded with orange. | *Firefly.* |
| | *Princess Victoria.* |

At another place or in another season these varieties might not have given us the most satisfaction; but these names suggest some of the colors, if one does not happen to have a seedsman's catalogue handy.

Of China asters, the Comet type—in various colors—will probably give the most satisfaction. They are mostly large-growing kinds. Other excellent kinds are the Perfection and Peony-flowered, Semple or Branching, Chrysanthemum-flowered, Washington, Victoria, and, for early, Queen of the Market. Odd varieties are Crown, German Quilled, Victoria Needle and Lilliput. Very dwarf kinds are Dwarf Bouquet or Dwarf German, and Shakespeare.

Anyone who wants to know more about sweet peas may have our Bulletins 111 and 127, and for China asters Bulletin 90. Our Bulletin 121 has instructions about laying out yards. Instructions on spraying, with formulas, are contained in Bulletin 114.

Now, let us see how many little boys and girls in New York State will raise sweet peas and China asters this year! And we should like them to write us all about it.

23.—*A clump of weeds in the corner by the house,—motherwort and Virginia creeper. How pretty they are!*

To the Teacher:

*Will you not help us to interest the children in the life of the gardens and fields? We suggest that you read this simple leaflet to them; and if any of them want a copy for themselves, tell us how many you want and we shall be glad to send them to you.*

*The leaflets which we have previously issued are:*

1. *How a squash plant gets out of the seed.*
2. *How a candle burns.*
3. *Four apple twigs.*

*You will receive one upon insects in a few days.*

*Address,*

*Chief Clerk,*

*College of Agriculture,*

*Ithaca, N. Y.*

ITHACA, N. Y., May 11, 1897.

The demand for "The Children's Garden" still continuing, and the season for sweet pea planting being past, it seems to be necessary to say that there are many interesting and satisfactory kinds of flowers which still can be sown. The China Aster (which we have recommended) may still be planted. One of the chief merits of this plant for our purpose is the lateness of bloom, allowing the flowers to be used in the schools after they open in the fall. An excellent flower for sowing during May is the common annual Phlox (*Phlox Drummondi* of the catalogues). Poppies are also satisfactory, but the flowers do not last long. Petunias are also excellent. Balsams, Clarkias, Coreopsis (or Calliopsis), and Zinnias may still be sown.

THIRD EDITION.

No. 5.

JUNE 1, 1897.

# TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

PREPARED BY

## THE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,

ITHACA, N. Y.

Issued under Chapter 128 of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

# Some Tent-Makers.

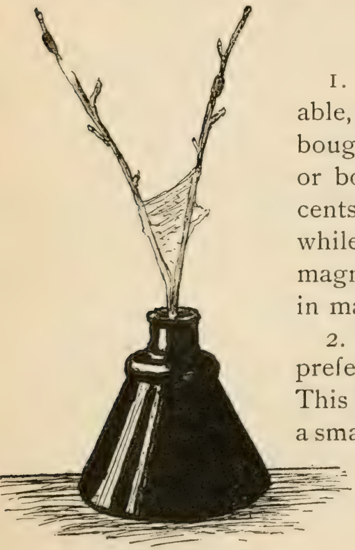
BY ANNA BOTSFORD COMSTOCK.

It is unfortunate that there is, throughout the country, a prevailing dislike for the small creatures called "worms." This dislike is, in most instances, the result of wrong training and is by no means a natural instinct. As evidence of this, witness the joy with which the small boy or even the small girl, handles "bait" when preparing to go fishing; although of all common "worms" surely the angle-worm is least attractive from any point of view. A still more striking example is the hardihood with which young fishermen catch the "dobson" to use as a lure for bass,—for the "dobson" is not only very ugly in appearance but is also vicious, often pinching severely the careless fingers of its captors. Thus the dislike for insects being the result of the point of view, it should be the first duty of the teacher to remove this repulsion. In the lesson which follows there is no occasion for teacher or pupil to touch the insects unless they choose to do so; but an attempt is made to arouse an interest in the habits and ways of insect life. If we can succeed in arousing the child's interest in the actions of a caterpillar, he will soon forget his dislike for the "little brothers" which live upon foliage and which experience miraculous changes of form during their short lives.

In selecting the Apple-tree Tent Caterpillar for this first lesson upon insects, we have been guided by the following facts: First, it is to be found in early spring; second, its life-history from

egg to cocoon is accomplished within the limits of the spring term of our schools: third, it is common everywhere; fourth, it is an important insect from an economic point of view, and the children may be taught how to keep it out of the orchards, thus making the lesson of practical use.

In this lesson the teacher is encouraged to use her own methods and originate new ones to make the work interesting. The leaflet is meant for the exclusive use of the teacher and the text should not be shown to the pupils. The pictures on the last page* are to be shown to the pupils at the teacher's discretion. When answers are herein given to the questions asked, they are meant to aid the teacher in drawing out the correct replies from the children.



24. *The bottle with the twigs bearing the egg masses. The tent is being woven below.*

## MATERIALS NEEDED.

1. A pocket lens or a tripod lens is desirable, but not a necessity. These may be bought from or ordered through any jeweler or bookseller. They cost from twenty-five cents to one dollar apiece. It is well worth while to any teacher to possess one of these magnifiers as a means of interesting her pupils in many ways.

2. A bottle, a broad bottomed one being preferable, so that it will not tip over easily. This bottle is to be filled with water in which a small branch of the apple-tree may be placed to keep it fresh. A common ink bottle will do to begin with. Fig. 24.

3. A wooden or pasteboard box, twelve or fourteen inches square,—a soap box or hat box will do. In place of a cover, nail or paste mosquito netting or cheese cloth over the top; remove the bottom so the box may be placed over the bottle and

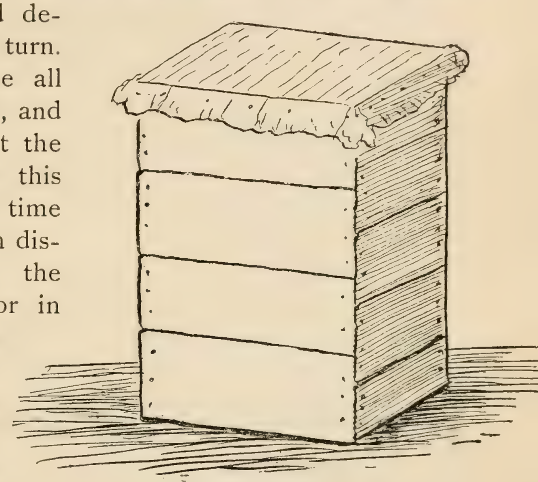
* Teachers who desire to take up this teaching should write us for enough extra sheets of page 47 to supply the scholars.

the branch of apple in it. This is called a breeding-cage and its use is to keep the insects from straying about the schoolroom. Fig. 25.

4. A twig bearing the egg mass of the tent caterpillar. Fig. 27. These are easily found before the leaves appear on apple trees or on wild cherry.

## Methods of Using this Leaflet.

The teacher should give the pupils a preliminary talk upon tents. Speak of the tents used by Indians, by armies, by circuses, by campers, and describe them each in turn. The teacher should use all the facts at her disposal, and all her ingenuity to get the children interested in this subject. Spend a little time for two or three days in discussing tents, and get the pupils to tell orally or in essays all they know about tents. When sufficient interest is thus aroused tell them this: "The reason we have talked about tents is because we are going to study some little folks who make tents and live in them. Their tents are not made of bark like the Indian's or of canvas like the soldier's, but are made of the finest silk, which is spun and woven by the tenters themselves. These silken tents are not pitched upon the ground and fastened down by ropes and pegs, for these folk, like the Swiss Family Robinson, live in trees. Many people live in one of these tree tents, and they are all brothers and sisters. Now, just where these tents are made and how they are made, and what sort of little people make them are things which we will find out if we watch carefully and patiently."



25. *The breeding cage.*

## Lesson I.—The Eggs. (Fig. 27.)

The teacher having found the egg mass should show it to the pupils and let them, during play hours, collect some for themselves. Say that they are eggs, but explain no farther. Get the children to examine the egg masses and ask the following questions:

On what portion of the trees are these egg masses found ?

What is the shape of the egg mass ? (Bring out the fact that they look like a portion of the twig swollen or budded.)

What is the color of the egg mass ?

Is there much difference in color between the egg mass and the branch ?

Has this similarity in color any use ? (Develop the idea that the shape and color of the egg mass makes it resemble the twig so closely as to hide it from birds or any animal that would be likely to eat the eggs.)

Does the egg mass shine ?

Why does it shine ?

*Ans.* Because there is a coat of varnish around the eggs.

Why was varnish put around the eggs ? (Get the answer by asking why varnish is put upon wood. Varnish is put around the eggs to preserve them and keep them dry during the rains and snows of autumn and winter.)

If the eggs are near the hatching period the varnish will have scaled off, revealing the tiny white eggs ; if not, let the teacher remove the varnish with a knife or pin, thus exposing the eggs. If the teacher has a lens the children should view the eggs through it. Exhibit the picture, Fig. 28, which represents the eggs greatly enlarged, showing the net work of cement which holds them in place. Ask the children to compare the shape of these eggs with that of bird eggs, and bring out the fact that these are thimble-shaped. Then ask the pupils to guess what sort of a mother laid these eggs, cemented them fast with a net work and then covered them with a coat of waterproof varnish. After sufficient interest is aroused on this point, say to them : "One day last July a little moth or miller was flitting about the

tree from which these twigs were taken. If we could have been there and caught her we would have found her a pretty little creature with four wings covered with down and a soft fuzzy body. In color she was a pale rosy-brown, and had two bands of pale yellow across each front wing." (Call attention to the picture of the moth, Fig. 31.*)

"This is the little mother which laid her eggs in a ring around the twig and covered them with a water-proof coat to keep them safe and sound until this spring, when they will hatch."

What will come out of these eggs when they hatch? The teacher should not answer this question but let the pupils watch the eggs and discover the answer for themselves.

Place the twig with the egg mass upon it in the bottle of water (Fig. 24). It will be best if this twig is a part of a forked branch, so that the caterpillars may make their web upon it. As soon as the eggs hatch, ask the following questions:

What sort of young ones hatch out of the eggs?

Are they like their mother?

What color are they?

Why are their heads so large?

*Ans.* So that they can gnaw the lid off the egg and thus get out.

Why should the young ones of a pretty moth be little black caterpillars?

(Leave this answer for future investigation.)

After the caterpillars hatch, it will be necessary to bring in fresh apple twigs with buds and leaves upon them each day so as to feed the little prisoners. It is very desirable that they be kept alive until they have begun their web and have molted at least twice. If they show a disposition to wander off put the breeding cage, Fig. 25, over the bottle and branch and so keep them confined with their food.

To supplement the study of the imprisoned caterpillars, study should be made at the same time of the insects out of doors and

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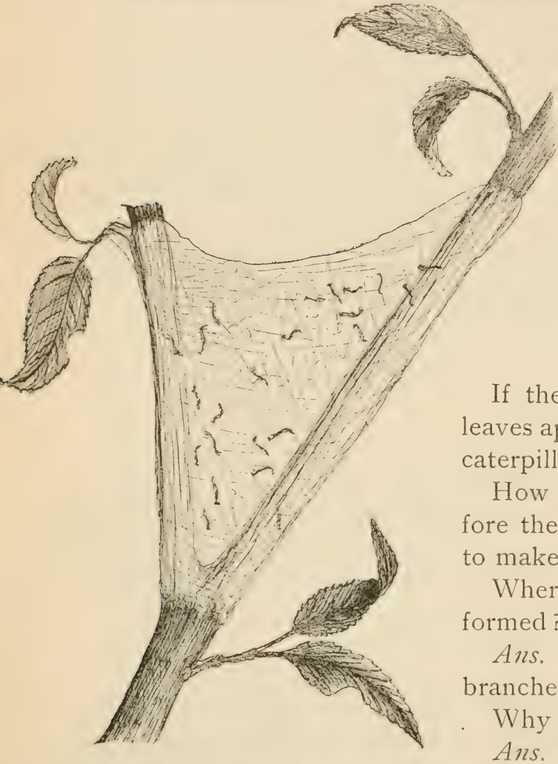
* If a specimen of the moth could be obtained it would be much more interesting to the children than the picture. The teacher can collect or breed the moths in July to use the next spring to illustrate the lesson.

under natural conditions. If none appear upon an apple or wild cherry tree near the school-house, the teacher should transfer a colony to such a tree (Fig. 26). This may be done by fastening a twig with an egg mass upon it to a branch of the tree. If too late to get the unhatched eggs, get a nest with the small worms in it and tie that to the convenient branch instead. This study of the insects out of doors is very necessary in discovering their normal habits.



26. *A young colony of tent-makers upon a cherry tree.*

### Lesson II.
### The Caterpillars.
### (Fig. 29.)

If the eggs hatch before the leaves appear, upon what do the caterpillars feed?

How long after hatching before the caterpillars commence to make their tent?

Where is the tent always formed?

*Ans.* In the fork of the branches.

Why is this so?

*Ans.* The forking branches offer a convenient support upon which to stretch the tent and when, as is the case out of doors, the tent is spread in a fork of the larger limbs, these limbs afford two branching roads for the caterpillars to follow in searching for food.

Let the pupils make drawings of the tent as soon as it is large enough to be seen well.

What is the color of the caterpillars when they are a week old?
Upon what do they feed?

At what time of day do they feed?

When on a tree, how far from their tent do they go for their food?

Are the paths over which the caterpillars travel when searching for food marked in any way?

*Ans.* This caterpillar spins a silken thread wherever it goes and therefore leaves a trail of silk behind it.

Of what is the tent made?

Compare the tent with a spider's web and note the differences.

Where does the silk come from, of which the tent is made?

*Ans.* The silk glands of the caterpillar are situated near the mouth, while those of the spider are on the rear end of the body.

## LESSON III. HOW THE INSECTS GROW.

The caterpillars shed their skins about five times. The first molt occurs about three days after they hatch. The second molt about four days later; and the third molt about six days after the second. After each molt, the color and markings of the caterpillars are somewhat changed. During some of the molts the pupils should watch a caterpillar change his skin. After the class has seen this operation the teacher may give the following lesson:

Where is your skeleton?

What is it made of?

What is it for? Bring out the fact that the skeleton is a support for the muscles and organs of the body.

Where is an insect skeleton? Get as many answers to this question as possible, then say:

The insect's skeleton is on the outside of its body instead of a skin, and the flesh and muscles are supported by it on the inside instead of on the outside like our own. As this skeleton is hard, it cannot stretch; as the insect grows and gets too large it bursts open and the insect walks out of it. Now, underneath this old, hard skeleton a new one is formed which is soft and flexible at first and so stretches to accommodate the growing insect. After a little time this new skeleton also

hardens and has to be shed when it is too small to suit its owner.

Notes should be made by the pupil upon the change of color and markings after the different molts and the process of molting should be described.

### Lesson IV. The Pupa. (Fig. 30.)

In ordinary seasons, about the middle of May the caterpillars get their growth. If those in the breeding cage have died or have not thriven, bring in a few full grown caterpillars from the orchard and put them on some branches in the breeding cage. Give them fresh food each day as long as they will eat; also place some sticks and chips around on the bottom of the breeding cage for the worms to "spin up" upon. Then have the children observe the following things:

How do the caterpillars begin their cocoons.

Where are the cocoons made?

How are they made?

Draw a picture of a cocoon?

About a week after a cocoon is made open it carefully with a pair of scissors so as not to hurt the inmate and let the pupils see the change that has come over the caterpillar.

Have the pupils describe the pupa.

Let the pupils make drawings of the pupa.

The moths will hardly emerge from the cocoons until after the close of the school term. The children should be encouraged to gather the cocoons off the fences around the orchards and off the sticks and branches upon the ground and to carry them home. The cocoons may be placed in pasteboard boxes and kept until the moths emerge, about the middle of July.

### Lesson V. Destroying the Caterpillars.

After the caterpillars are fully grown and all the processes of growth have been observed by the pupils, the teacher should give a lesson upon the injury which they do to trees and the necessity of keeping the orchards free from these pests. This

lesson should be given guardedly so as not to encourage the children to cruelty in killing insects. The teacher should always try to inculcate in the child reverence for life, that wonderful force, which we can so easily take from a creature but which we may never give back. It is better to appeal to the child's sense of justice in giving this lesson. The teacher may vary it to suit her own ideas, but in substance it might be given as follows:

"All life is sacred; the smallest worm has as good a right to live in the sight of God as you or any child has. Life should never be taken except when necessary. However, no being has the right to interfere with the rights of another. Neither the child nor the worm has any right to trespass upon the property of any one else."

"Let us see whether these caterpillars are trespassers or not. The farmer works hard to earn the money to buy the land upon which the orchard is planted; he works hard to earn the money with which to buy the young trees; he works hard to set out the trees and cultivate the orchard: therefore the orchard and the fruit of it are his property, and he has a right to drive away all thieves. If men or children steal the fruit, he has a right to appeal to the law and have them fined or imprisoned. If worms come and injure the tree by eating up the foliage, he has a right to keep them out if he can. The leaves are necessary to the tree, for if they are destroyed the tree cannot get the air it needs to keep it vigorous and enable it to mature its fruit. We have seen that these caterpillars destroy the leaves, and thus do great injury to the apple crop. We therefore have a right to destroy these little robbers, as that is the only way we can keep them out of our orchards."

How may they be destroyed?

The egg masses may be collected in winter and early spring from young orchards, and be burned.

In old, large trees we must wait until later. Ask the pupils the following questions:

At what times did we find the worms in their tents? *Ans.* Early morning, late afternoons, and during cold, dark days.

If we should destroy the tents in the middle of a warm,

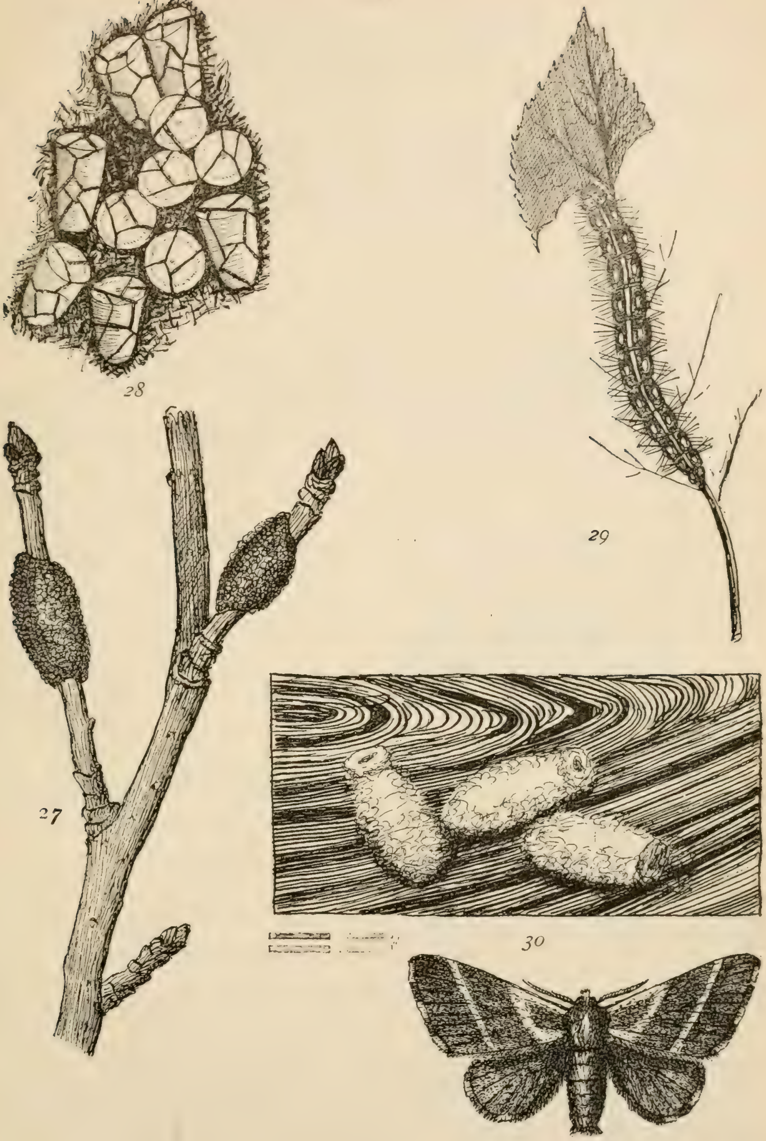
sunny day, what would happen? *Ans.* The caterpillars, being out feeding on the leaves, would not be hurt, and as soon as they came back would make another tent.

If the tent is destroyed in the early morning or late afternoon or on a cold, dark day, what would happen? *Ans.* The caterpillars, all being in the tent, would be destroyed. How may the tents be destroyed? *Ans.* By wiping them out with a long pole on one end of which is wound a rag saturated with kerosene. Or by burning them out with a torch.

Is it best to destroy the caterpillars early in the season, before they have done much damage, or to wait until they are large and have done all the damage they can?

If the trees were sprayed with Paris-green in the early spring, what would happen? *Ans.* The caterpillars would be killed as soon as they commenced to eat, when they were first hatched.

When these caterpillars feed upon the leaves of wild cherry they are doing no damage to an orchard. Therefore, when the tents appear on wild cherry trees have we any right to destroy them? *Ans.* The wise and careful farmer does not allow wild cherry trees to grow along his fences, to become breeding places for insect enemies which will next year attack his orchards.




THE CURIOUS HISTORY OF A TENT CATERPILLAR.

*27. The masses of eggs upon the twigs of an apple tree. 28. The eggs enlarged. 29. A full-grown caterpillar. 30. Cocoons. 31. The moth, or adult insect.*

TO THE TEACHER:

*The following leaflets have been issued to aid teachers in the public schools in presenting nature-study subjects to the scholars at odd times.*

1. *How a squash plant gets out of the seed.*
2. *How a candle burns.*
3. *Four apple twigs.*
4. *A children's garden.*
5. *Some tent-makers.*

*Address,*
*Chief Clerk,*
*College of Agriculture,*
*Ithaca, N. Y.*

SECOND EDITION.

# TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

No 6.

JUNE 1, 1897.

PREPARED BY

THE COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY,
ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.


# What is Nature-Study?

BY L. H. BAILEY.

It is seeing the things which one looks at, and the drawing of proper conclusions from what one sees. Nature-study is not the study of a science, as of botany, entomology, geology, and the like. That is, it takes the things at hand and endeavors to understand them, without reference to the systematic order or relationship of the objects. It is wholly informal and unsystematic, the same as the objects are which one sees. It is entirely divorced from definitions, or from explanations in books. It is therefore supremely natural. It simply trains the eye and the mind to see and to comprehend the common things of life; and the result is not directly the acquirement of science but the establishment of a living sympathy with everything that is.

The proper objects of nature-study are the things which one oftenest meets. To-day it is a stone; to-morrow it is a twig, a bird, an insect, a leaf, a flower. The child, or even the high school pupil, is first interested in things which do not need to be analyzed or changed into unusual forms or problems. Therefore, problems of chemistry and of physics are for the most part unsuited to early lessons in nature-study. Moving things, as birds, insects and mammals, interest children most and therefore seem to be the proper subjects for nature-study; but it is often difficult to secure specimens when wanted, especially in liberal quantity, and still more difficult to see the objects in perfectly natural conditions. Plants are more easily

had, and are therefore more practicable for the purpose, although animals and minerals should by no means be excluded.

If the objects to be studied are informal, the methods of teaching should be, also. If nature-study were made a stated part of a curriculum, its purpose would be defeated. The chiefest difficulty with our present school methods is the necessary formality of the courses and the hours. Tasks are set, and tasks are always hard. The only way to teach nature-study is, with no course laid out, to bring in whatever object may be at hand and to set the pupils to looking at it. The pupils do the work,—they see the thing and explain its structure and its meaning. The exercise should not be long,—not to exceed fifteen minutes at any time, and, above all things, the pupil should never look upon it as a recitation, and there should never be an examination. It should come as a rest exercise, whenever the pupils become listless. Ten minutes a day, for one term, of a short, sharp and spicy observation upon plants, for example, is worth more than a whole text-book of botany.

The teacher should studiously avoid definitions, and the setting of patterns. The old idea of the model flower is a pernicious one, because it really does not exist in nature. The model flower, the complete leaf, and the like, are inferences, and pupils should always begin with things and not with ideas. In other words, the ideas should be suggested by the things, and not the things by the ideas. "Here is a drawing of a model flower," the old method says; "go and find the nearest approach to it." "Go and find me a flower," is the true method, "and let us see what it is."

Every child, and every grown person too, for that matter, is interested in nature-study, for it is the natural method of acquiring knowledge. The only difficulty lies in the teaching, for very few teachers have had any drill or experience in this informal method of drawing out the observing and reasoning powers of the pupil wholly without the use of text-books. The teacher must first of all feel the living interest in natural objects which it is desired the pupils shall acquire. If the enthusiasm is not catching, better let such teaching alone.

All this means that that the teacher will need helps. He will need to inform himself before he attempts to inform the pupil. It is not necessary that he become a scientist in order to do this. He simply goes as far as he knows and then says to the pupils that he cannot answer the questions which he cannot. This at once raises the pupil's estimation of him, for the pupil is convinced of his truthfulness, and is made to feel—but how seldom is the sensation!—that knowledge is not the peculiar property of the teacher but is the right of any one who seeks it. It sets the pupil investigating for himself. The teacher never needs to apologize for nature. He is teaching only because he is an older and more experienced pupil than his pupil is. This is just the spirit of the teacher in the universities to-day. The best teacher is the one whose pupils farthest outrun him.

In order to help the teacher in the rural schools of New York, we have conceived of a series of leaflets explaining how the common objects can be made interesting to children. Whilst these are intended for the teacher, there is no harm in giving them to the pupil; but the leaflets should never be used as texts to make recitations from. Now and then, take the children for a ramble in the woods or field, or go to the brook or lake. Call their attention to the interesting things you meet—whether you yourself understand them or not—in order to teach them to see and to find some point of sympathy; for everyone of them will some day need the solace and the rest which this nature-love can give them. It is not the mere information which is valuable; that may be had by asking someone wiser than they, but the inquiring and sympathetic spirit is one's own.

The pupils will find their lessons easier to acquire for this respite of ten minutes with a leaf or an insect, and the school-going will come to be less perfunctory. If you must teach drawing, set the picture in a leaflet before the pupils for study, and then substitute the object. If you must teach composition, let the pupils write upon what they have seen. After a time, give ten minutes now and then to asking the children what they saw on their way to school.

Now, why is the College of Agriculture of Cornell University interesting itself in this work? It is trying to help the farmer, and it begins with the most teachable point,—the child. The district school cannot teach agriculture any more than it can teach law or engineering or any other profession or trade, but it can interest the child in nature and in rural problems and thereby fasten its sympathies to the country. The child will teach the parent. The coming generation will see the result. In the interest of humanity and country, we ask for help.

To the Teacher:

*The following leaflets have been issued to aid teachers in the public schools in presenting nature-study subjects to the scholars at odd times.*

1. *How a squash plant gets out of the seed.*
2. *How a candle burns.*
3. *Four apple twigs.*
4. *A children's garden.*
5. *Some tent-makers.*
6. *What is nature-study?*

*Address,*

*Chief Clerk,*

*College of Agriculture,*

*Ithaca, N. Y.*

**TEACHER'S LEAFLETS**

FOR USE IN THE PUBLIC SCHOOLS.

No. 7.

JUNE 1, 1897.

PREPARED BY

**THE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,**

ITHACA, N. Y.

Issued under Chapter 128 of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

# Hints on Making Collections of Insects.

BY ANNA BOTSFORD COMSTOCK.

IT is the purpose of this leaflet to give a few suggestions to aid those pupils of the secondary schools, who desire to make collections of insects.

There are several good reasons why children should be encouraged to make collections of flowers, birds and insects; and the least of these reasons is the possession of such a collection on the part of the child. Making a collection of natural history specimens should only be the means to an end, *i. e.*, training the child to observe. When eyes are opened to the wonders of nature, every roadside, brook, and woodland is fraught with interest which is undreamed of to those who are nature-blind. It is sad to think of the hosts of people who go through this beautiful world having eyes but seeing not, having ears but hearing not. The eyes must be unsealed in youth, when the mind is alert and receptive if the man or woman is to find in later life that nature is not only a resource and recreation but an ever faithful friend holding out comforting arms to those who are weary in soul and body.

Not only does the study of nature open the child's eyes, but it also teaches him the value of accuracy. The young naturalist

soon understands that an observation is worth nothing unless it is truthful. On the other hand, nature-study cultivates the imagination. The wonders in the lives of insects, plants and birds are so illimitable that almost anything *seems* possible. Few indeed are the studies wherein the fire kindled by imaginative *seeming* is guarded and checked by the facts of actual *seeing*.

There are a few points in favor of beginning with insects when the child first attempts making a collection of natural objects. Insects are to be found everywhere and are easily caught; and it requires no technical skill to preserve them as is the case with birds; while they retain their natural forms and colors better than do flowers. To secure the desired results for the pupil when he is making his collection of insects the teacher should take care that he makes his observations incidentally; thus subserving the true methods of nature-study, which is to teach the child while he remains unconscious of the fact that he is being taught. The teacher should therefore ask the young collector "Where did you catch this butterfly?" "Where did you find this beetle?" "Upon what plant or flower did you find this bug?" "Did you hear this cricket chirp? If so, how did he do it?" etc., etc. Thus making him tell orally or in a written language lesson the things he has seen while collecting. The differences in the appearance and structure of the insects caught should also be brought out by questions. These questions may be adapted to pupils of any age and the success of this part of the work must ever depend upon the interest and genius of the teacher.

The objection is sometimes raised that collecting and killing insects and birds incite the child to cruelty and wanton destruction of life. This seems good *a priori* reasoning but experience does not confirm it. We have always found that those who collect and take an interest in insect life are much more careful about killing or hurting insects than are other people; the entomologist of all men taking the greatest pains to avoid stepping upon the caterpillar or cricket in his path; also the young ornithologists who have come under our observation show the greatest devotion to the rights and interests of birds. Our experience is that as soon as the child begins to take an interest in insects he begins to see matters from their point of view and this insures a proper regard for their right to life. It will be well, however, for the teacher to impress upon the pupil that he should kill no insect that is not desired for his collection.

## DIRECTIONS FOR COLLECTING AND PRESERVING INSECTS.

The articles necessary for collecting insects are few and inexpensive. One net and one killing bottle may do service for a grade or an entire country school, thus reducing the expense to a minimum.

### INSECT NET. Fig. 1.

*Materials required:*

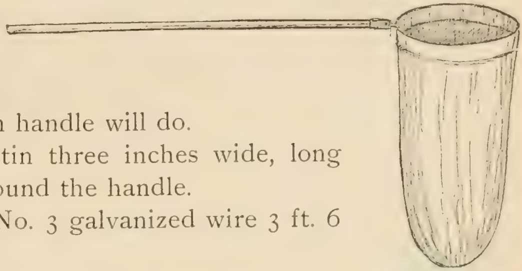


FIG. 1. *Insect net.*

1. A handle about three feet long; an old broom handle will do.
2. A piece of tin three inches wide, long enough to reach around the handle.
3. A piece of No. 3 galvanized wire 3 ft. 6 in. long.
4. ⅙ yard of heavy sheeting.
5. ¾ yard of cheese cloth.

Bend the wire into a ring about a foot in diameter and bend back about 3 inches of each end of the wire so they may be inserted into a hole drilled into the end of the handle. The piece of tin should be fastened around the end of the handle where the wire is inserted to hold it securely in place. If practicable a tinsmith should be called upon to help in bending the wire and fastening it to the handle. After this is done take the sheeting and fold it over the wire double, using only enough to fit around the wire without gathering; the object of this heavy cloth is to prevent the net from wearing out quickly. Make the cheese cloth into a bag with rounded bottom and just wide enough to fit the facing of sheeting to which it should be sewed securely, and the net is finished.

### HOW TO USE THE NET.

The net must be swung swiftly to be successful. Insects have many eyes and are very wide-awake and have no desire to be caught; therefore, the collector must be very active if he gets anything. One method of using the net is called "sweeping"; to do this take the handle about a foot and a half above the ring and pass the net quickly back and forth,

striking it against the grass in front of you as you walk through open fields; the net must be turned at each stroke and kept in rapid motion or the insects will escape. After a time the net should be examined and the insects put in the killing bottle.

Another method of using the net is called "beating." This method is used in collecting insects from bushes and consists of lifting the net, mouth upward, and striking it sharply against the branches or leaves, thus jarring the insects into it.

To use the net in water sweep the water plants as quickly as possible. In running streams overturn stones, holding the net just below them with the mouth up stream. An old dipper made into a sieve by perforating the bottom with an awl is a good utensil for collecting water insects.

## The Killing Bottle, Fig. 2.

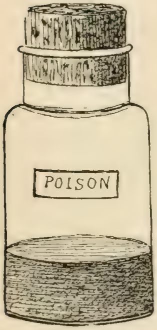



Fig 2. *Killing bottle.*

It is desirable to kill the insects in a humane way so that they will not suffer by the process; it is also desirable that they should not revive after they are pinned, both for their own sakes as well as for the sake of the feelings of the collector. The best way to secure painless and sure death for the insects is by the means of a "cyanide bottle."

*Materials needed for a killing bottle:*

1. A bottle with a wide mouth; a morphine bottle or a small olive or pickle bottle will do. Even a glass fruit-can holding a pint will answer very well, although taking off and putting on the cover consumes more time than is desirable.

2. A cork that will fit the bottle tightly and is long enough to handle easily.

3. Two cents' worth of cyanide of potassium.

4. One cent's worth of plaster of Paris.

These latter materials may be procured from any drug store.

Place the lump of cyanide of potassium in the bottle and pour in enough water to cover it. Add immediately enough plaster of Paris to soak up all the water; leave the bottle open in a shady

place for an hour and then wipe the dry plaster of Paris from its sides, put in the cork, and it is ready for use. The plaster of Paris forms a porous cement which, while it holds the cyanide fast in the bottom, also allows the fumes of the poison to escape and fill the bottle. It should be labeled "poison." If kept corked when not in use a killing bottle made like this will last a whole season.

The first rule in using the killing bottle is this: Do not kill any more insects than you need for your collection. The second rule is: do not breathe the fumes of the bottle; for they smell badly and are not good for you. When you uncork the bottle to put an insect in it hold it away from your face and cork it up again as quickly as possible.

Some insects may be caught from flowers, etc., directly into the bottle by holding it uncorked beneath them for a moment; the fumes of the poison soon overcome them and they drop into the bottle. In taking insects from the net take the bottle in the right hand and the cork in the left; insert the bottle into the net and place the mouth of it over an insect crawling on the inside of the net, then put the cork on the outside of the net into the mouth of the bottle, net and all, for a moment until the insect falls into the bottom of the bottle; then remove the cork and take the rest of the imprisoned insects in the same way. Insects should be left in the bottle at least an hour, and may be left in there over night without injury to the specimens.

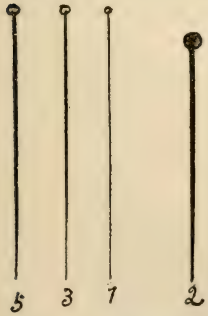



FIG. 3. *Insect pins* 1, 3, 5, *are German insect pins.* 2, *is a steel mourning pin.*

INSECT PINS. FIG. 3.

After the insects are caught they should be pinned so that they may be arranged in the collection in an orderly manner. Common pins are not good for pinning insects; they are too thick and they corrode very soon, covering the specimens with verdigris. Regular insect pins are desirable as they are very slender and do not corrode so quickly. These may be obtained of any dealer in entomological supplies at a cost of fifteen cents per hundred.

Ask for the German insect pins Nos. 1, 3 and 5. If these pins are too expensive you

can use the black steel mourning pins. These come in shallow boxes one by two inches square and have round glass heads and the boxes are labeled "Germany"; these may be procured from any dry goods store. However, insects pinned with any beside regular insect pins cannot be sold or exchanged.

All insects except beetles should be pinned through that part of the body just back of the head as shown in Figs. 11, 13, 14, 15. Beetles should be pinned through the right wing-cover as shown in Fig. 12. About one-fourth of the pin should project above the back of the insect. Very small insects may be gummed to a narrow strip of cardboard and the pin put through the cardboard.

## LABELING SPECIMENS.

Specimens should be labeled with the date of capture and the locality. Thus the butterfly, Fig. 15, would be labeled thus:

Ithaca, N. Y.
Aug. 12, 1896.

The paper on which this label is written should be slipped upon the pin with which the butterfly is pinned and placed just below the insect. Labels should be as small as possible and neatly cut.

## INSECT BOXES.

For the beginner nothing is more convenient than an empty cigar box, which may be obtained at any store where cigars are sold. (Fig. 4.) The bottom of the box should be covered with

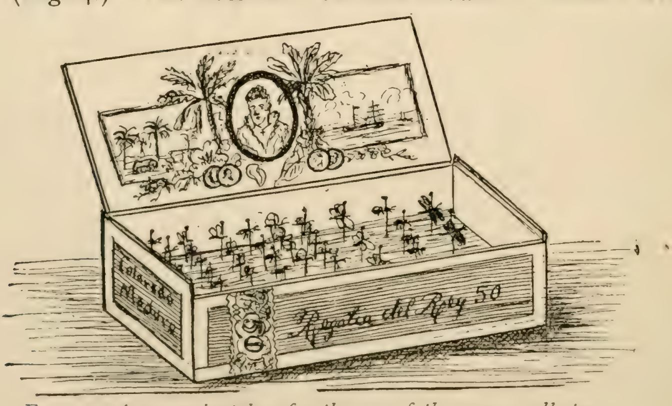


FIG. 4. *A convenient box for the use of the young collector.*

some soft, firm material into which pins may be pushed without bending them. There are many such materials. Sheet cork or pressed peat may be obtained of dealers in entomological supplies. Some ingenious boys use regular bottle corks cut into cross sections about ¼ inch thick. Others take the pith of dried corn-stalks divided in half lengthwise. The cheapest and most easily procurable of the purchasable materials is cork linoleum. This is for sale in most carpet stores. Get the quality that is about ¼ inch thick which costs about $1 per yard; put it into the box cork-side up. Any of these materials may be fastened to the bottom of the box with glue or with tacks. In all cases they should be covered neatly with white paper for the insects appear better against a white background.

For permanent collections the wooden boxes with glass tops are much safer; and as the insects may be seen through the glass these boxes are more practical for school collections. This kind of a box is shown in Fig. 5. Its sides are 18 by 16 inches and its

FIG. 5. *Insect box made of wood, with glass top.*

height is three inches outside measure. The upper edge of the sides of the bottom of the box is made with a tongue which fits into a groove made in the lower edge of the sides of the cover. This is done so that the top and bottom parts of the box shall fit very closely together in order that museum pests cannot get in and destroy the specimens.

Fig. 6 shows a cross-section through one side of the box, showing how it should be made and giving measurements. In the drawing the glass is fitted into a groove in the inner side of the cover. This glass might be puttied in like a window pane if it is found difficult to make the groove. The corners of the box may be mitred and dove-tailed or mitred and nailed; the latter is

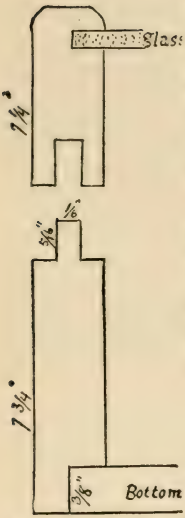



FIG. 6. *A cross-section of the side of insect box* FIG. 5, *showing method of construction and giving measurements.*

more easily done. Any carpenter or cabinet maker can make this box; but great care must be taken to use only thoroughly seasoned wood in its construction. Otherwise the bottom will be sure to warp and shrink and leave cracks through which the museum pests will enter. The cost of such a box will vary from $0.75 to $1. Basswood should be used in the construction; pine is not at all suitable on account of the resin in it. Screw eyes may be put into these boxes and they may be hung on the walls of schoolroom like pictures.

### MUSEUM PESTS.

These are small beetles which find their way through the narrowest crevice into the insect boxes and lay their eggs on the pinned insects. The larvæ when they hatch work within the specimens at first but after a time destroy the bodies entirely. The presence of these little rascals may be detected by dust on the bottom of the box just below the infested insect. As soon as this dust is observed, pour into one corner of the box a tablespoonful of carbon bisulphide, or benzine, and close the box quickly. The teacher or parent should put these substances into the boxes as the first is a poison and the latter is very inflammable. As a method of preventing the beetles from attacking the collection it is well to fasten a "moth ball" into one corner of the box. These may be obtained at a drug store.

## SPREADING BOARD.—FIG. 7.

Butterflies and moths look much better in a collection when their wings are extended at right angles to the length of the body. To arrange them thus we have to use what is termed a spreading-board.

*Materials needed for a medium sized spreading-board.*

1. Two strips of pine or other soft wood 18 inches long, 1 ½ inches wide and ½ inch thick.

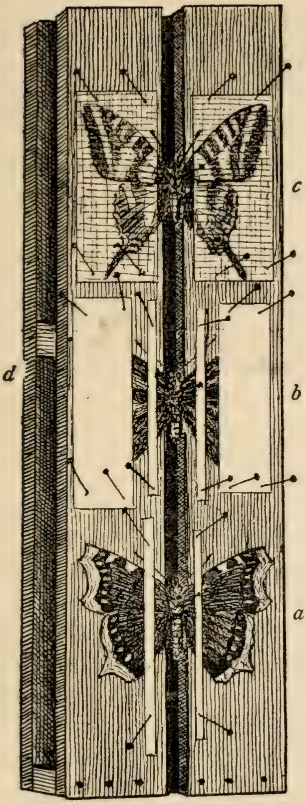



FIG. 7. *A spreading board.*

2. One strip of wood 18 inches long, 3¼ inches wide and ½ inch thick.

3. Two cleats 3¼ inches wide, ¾ inch high and ½ inch thick; and two cleats one inch wide and as high and thick as the others.

4. A strip of cork or linoleum 17 inches long and a little less than an inch wide.

To construct the spreading board take the two narrow strips of wood, place them one-fourth inch apart and on the under side fasten them across the ends to the longer cleats. Then on the same side as the cleats tack the piece of cloth or linoleum over the space between the strips of board, and as the cleats are one-half inch wide the linoleum should cover all the space left. Then midway the boards fasten the two smaller cleats. Fig. 8 shows a cross-section of the spreading board just in front of these two middle cleats. Now it is ready for the bottom board which will fit exactly if directions are followed, and this completes it. The space between the two upper boards is wide enough to take in the body of the moth or butterfly. The cork or linoleum below the space will hold firmly the pin on which the butterfly is impaled. The cleats hold the top and bottom boards apart and so protect the points of the pins.

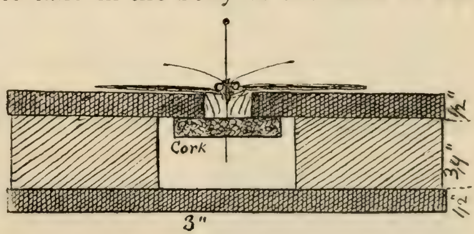



FIG. 8. *A cross section of spreading board in front of the cleat "d" in Fig. 7.*

Spreading boards may be made much smaller or much larger to suit moths of different sizes; the space between the top boards must always be large enough to admit the body of the insect.

To use the spreading board: insert the pin with the butterfly on it into the linoleum just far enough so that the body of insect will be in the space between the boards up to the wings, Fig. 8. Place the wings out flat on the board and fasten them there with narrow strips of paper pinned across them, Fig. 7, *a*. While held down by these strips of paper arrange them so that the hind margins of the front wings shall cover the front margins of the hind wings and shall be in a line at right angles to the body; then pin larger pieces of paper over the rest of the wings, Fig. 7, *b*. Sometimes isinglass is used instead of paper to hold the wings down, Fig. 7, *c*. The insects should be left on the spreading board at least three days; and when the board has insects on it, it should be kept in a box where the museum pests and mice cannot get at it.

Sometimes when the moths are not spread soon after being killed they become so stiff that the wings cannot be moved without breaking them. In such cases the insects should be put on some paper in a jar which has some wet sand in the bottom and which can be covered tightly. The air in such a can is so moist that in two or three days the insect will become limber and may be spread with ease.


FIG. 9. *An aquarium.*

## AN AQUARIUM. FIG. 9.

An aquarium with living, moving insects in it is a very interesting ornament for the window-sill of a schoolroom. A glass candy jar or even a butter jar may be transformed into such an aquarium thus: first, put into the jar a layer of sand about two inches deep; in this sand plant some small water weeds and then add a layer of gravel or pebbles; then nearly fill the jar with rain water, pouring it in carefully so as not to disturb the plants.

The plants will keep the water in a right condition for the water insects to live in; more water should be added from time to time to replace that which evaporates. In such an aquarium place any insects found in water and watch their habits.

## Where to Collect Insects.

The border of a piece of woods where many shrubs and weeds are growing is an especially good place for collecting many kinds of insects. Any place where there is a great variety of plants and flowers will give a variety of insects. Banks of streams and underneath stones in the fields are good places for collecting.

## When to Collect Insects.

The best time of the year is during the summer months. The best times of day is in the forenoon after eight o'clock; and in the twilight at evening.

At night many moths may be caught by making a paste of sugar and water (unrefined sugar is best) and painting it upon tree trunks with a brush after sunset. The paste should cover a space two inches wide and several inches long. After dark seek these places cautiously with a lantern and moths will be found sucking the paste: these may be caught with the killing bottle if you move carefully so as not to frighten them; they do not seem to mind the light of the lantern.

Electric street-lights attract many insects which may be caught in the net. A lamp set in an open window is also a very good lure on warm nights in the spring and summer.

## Arranging the Insects in Boxes.

After collecting insects comes the desire to arrange them properly; putting together in neat rows those that resemble each other. To classify insects correctly requires much study. The scope of this leaflet admits of only a few suggestions about the most common insects.

*Dragon Flies.*—There are many kinds of these but they all have four wings, finely netted and transparent, the hind wings being as large or larger than the front wings. These are perfectly harmless insects.

*Grasshoppers, Crickets and Katydids.*—These are known to all, Fig. 10. There are two families of grasshoppers; those with long horns or antennæ and those with short antennæ. Katydids, crickets, cockroaches and walking-sticks are near relatives to the grasshoppers.

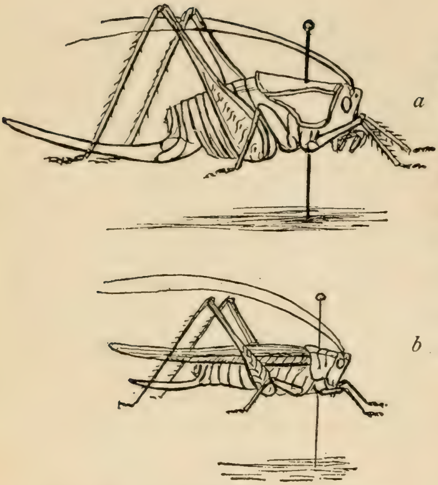



FIG. 10. *a, Cricket. b, Grasshopper.*

*Bugs.*—These insects have the front pair of wings thick and heavy at the base and thin and transparent at the tips, Fig. 11, *b*. The squash bug, the chinch bug, and the electric light bug are examples of these. Some bugs have the front wings entirely thin and transparent and sloping like a steep roof over the back of the insect like the cicada, Fig. 11, *b*; and the Brownie bug, Fig. 11, *c*, *d*.

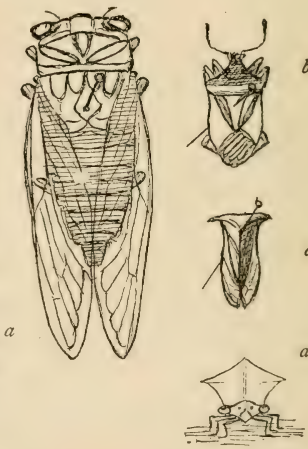



FIG. 11. *a, Cicada. b, Stink-bug. c, Leaf-hopper. d, Leaf-hopper—front view.*

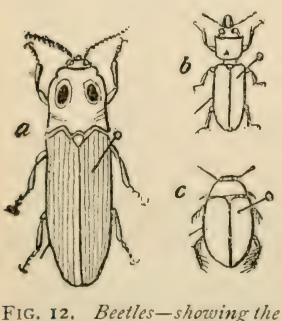



FIG. 12. *Beetles—showing the pin through the right wing cover. a, Snapping beetle. b, Wood-boring beetle. c, Water beetle.*

*Beetles.*—These have hard wing-covers which meet in a straight line down the back and have a pair of thin wings folded under them, Fig. 12. The "June bug" or "May beetle" and the potato beetle are good examples of beetles.

*Flies.*— These have only two wings, usually transparent. Behind each of these wings a short thread with a knob on it extends out on each side of the body instead of hind wings, Fig. 13.

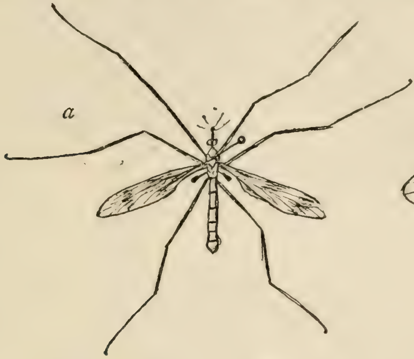




FIG. 13. *Flies—showing the knobs just below the wings. Note that flies have only two wings. a, Crane fly. b, Pomace fly—enlarged.*

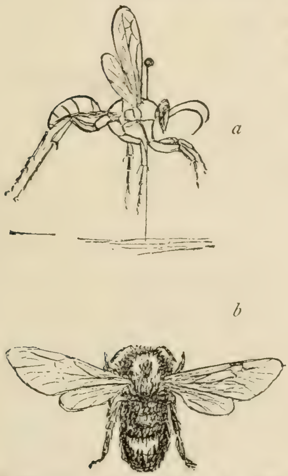



FIG. 14. *a, Wasp. b, Bee. Note these have four wings.*

FIG. 15. *The Red Admiral Butterfly. Note the knobbed antennæ.*

House-flies, horse-flies and mosquitoes are examples of flies.

*Bees, Wasps and Ants.*— Bees, wasps and the winged form of ants have four transparent wings, Fig. 14. Some flies resemble bees and wasps but if examined it will be found that they have only two wings instead of four.

*Butterflies and Moths.*— Butterflies and moths may be told apart by the following character: The antennæ or horns of the butterflies are always threadlike and knobbed at the tip, Figs, 15, 16, while the antennæ of moths are in various shapes, but never bear knobs at the tips, Figs. 17, 18, 19, 20.

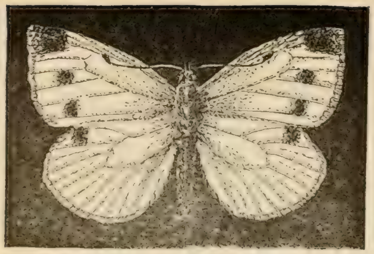


FIG. 16. *The Cabbage Butterfly.*

FIG. 17. *The Bass-wood leaf-roller moth.*

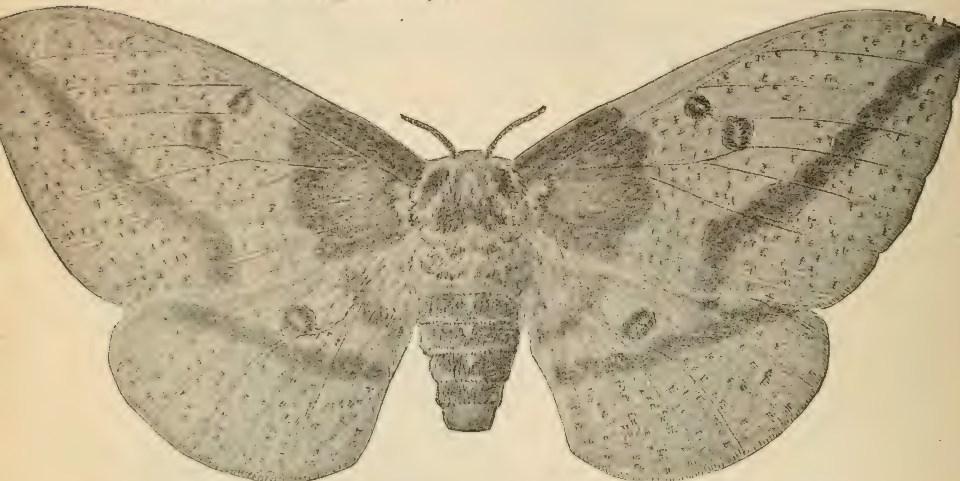


FIG. 18. *The Imperial Moth. A common night-flying moth.*

FIG. 19. *An Under-wing Moth.*

FIG. 20. *The Luna Moth. A common night-flying moth.*

DEALERS IN ENTOMOLOGICAL SUPPLIES.

The following is a list of the dealers in entomological supplies that have advertisements in the current American entomological journals :

A. Smith & Sons, 269 Pearl Street, New York, N. Y.
John Akhurst, 78 Ashland Place, Brooklyn, N. Y.
M. Abbott Frazar, 93 Sudbury Street, Boston, Mass.
Entomological Society of Ontario, Victoria Hall, London, Ont.
Queen & Co., 1010 Chestnut Street, Philadelphia, Pa.
The Bausch & Lomb Optical Company, 515–543 N. St. Paul Street, Rochester, N. Y.